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INDOOR AIR QUALITY

Selected References

U.S. Department of Health and Human Services
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health

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Selected References

U.S. Department of Health and Human Services
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health
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May 1989

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INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) has compiled this document in response to an increasing number of requests for information about indoor air quality, including sick building syndrome. Included in this publication are the NIOSH Congressional testimony presented before the Subcommittee on Energy Development and Applications; two articles describing the results of NIOSH research and findings on indoor air quality problems; NIOSH guidance on conducting indoor air quality investigations; and a description of the NIOSH health hazard evaluation program, which can provide NIOSH assistance in evaluating indoor air quality problems.

For further information, a list of additional non-NIOSH references is provided on the next page.

INDOOR AIR QUALITY
Additional References

The following non-NIOSH references provide additional information on indoor air quality. These references may be obtained from your local public or university library.

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CONGRESSIONAL TESTIMONY

TESTIMONY OF

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NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CENTERS FOR DISEASE CONTROL
PUBLIC HEALTH SERVICE
DEPARTMENT OF HEALTH AND HUMAN SERVICES

Before

Subcommittee on Energy Development
and Applications

Subcommittee on Natural Resources, Agriculture
Research, and Environment

Science and Technology Committee

United States House of Representatives

August 3, 1983

Good morning.

My name is Dr. James Melius, Chief, Hazard Evaluations and Technical Assistance Branch, National Institute for Occupational Safety and Health (NIOSH), of the Centers for Disease Control (CDC). I am happy today to testify on current investigations and research on indoor air quality being conducted by NIOSH and by the Center for Environmental Health (CEH) of the Centers for Disease Control.

The Center for Environmental Health was established in the Centers for Disease Control to implement environmental public health programs for a wide variety of problems. During the past several years, CEH has upon request, provided--primarily to State and local health departments--epidemiologic assistance or technical advice on specific indoor air pollution problems.

As you know, the National Institute for Occupational Safety and Health was established to conduct research in occupational health and safety; to develop criteria for safety hazards and occupational exposures to physical, chemical, and biological agents; to recommend these criteria to the Department of Labor for consideration in setting standards; and to train occupational safety and health professionals.

Most of NIOSH's research on indoor air quality has been done as part of the Health Hazard Evaluation and Technical Assistance Program. Under this national program, mandated by the Occupational Safety and Health Act and the Mine Safety and Health Act, NIOSH responds to requests for evaluation of occupational health problems from employers, employees or their unions, and other governmental agencies. After receiving a request, NIOSH investigators visit the workplace and may then collect appropriate industrial hygiene samples, evaluate the ventilation system, and conduct medical examinations or an epidemiological study, as necessary, to evaluate the extent of any occupational health problem in that facility. At the completion of each investigation, a publicly available report is issued to the requestors and other involved parties. The report includes the study findings and recommendations to correct specific occupational health problems in that workplace.

Since 1971, NIOSH has conducted over 200 indoor air quality investigations. More than 90 percent of these investigations were conducted in the last five years. Nearly all were conducted in response to worker symptoms or illnesses which were thought to be related to the building environment in which the people were working. Generally, the indoor air pollution evaluations that we have conducted are categorized by the source of contamination in the environment--if we can identify it--or, otherwise, by the type of symptoms or illnesses experienced by the workers. I will briefly explain some of these categories.

1. Contamination from Outside the Building: In some instances, we have traced the source of the complaints to contamination from outside the building. Occasionally, this outside source can be quite unusual, as in a recent investigation in which complaints of eye irritation and headaches among workers in a medical office led to our discovery of a large underground gasoline leak which was seeping into the basement and stairwells of the building. More often, the source of outside contaminants is more obvious, such as exhaust from an adjoining motor vehicle garage, construction site, or power plant.

2. Contamination from the Building Materials: In these evaluations, we find evidence of contamination from materials used to construct the building, such as fibrous glass insulation, carpet adhesive, or urea formaldehyde foam insulation. The health complaints are usually specific to a causative agent (dermatitis from fibrous glass, eye and upper respiratory irritation from formaldehyde). A related problem is contamination from deteriorating asbestos insulation used in many buildings constructed in the 1950's and 60's, a major problem in many buildings and one for which we are often asked to give advice and provide assistance.

3. Contamination from Copying Machines: In many instances, we have been asked to evaluate symptoms caused by exposure to contaminants from photocopiers, spirit duplicators, and similar office printing machines. In these investigations, we have evaluated exposure to specific chemicals which may be released by these machines (such as methyl alcohol from spirit duplicators, ozone or trinitrofluorenone from copying machines, and methacrylates from signature machines). The symptoms experienced by office workers using these machines are usually specific to the chemicals being released.

4. Hypersensitivity Pneumonitis: Over the past 3 years, we have conducted 10 investigations of hypersensitivity pneumonitis among office building employees. Hypersensitivity pneumonitis is a flu-like illness characterized by episodes of fever, chills, malaise, muscle aches, and, usually, chest tightness. These symptoms have usually improved after the affected workers leave the building (for vacations and weekends) only to recur when they return to the work environment. The cause of this illness is an immunological sensitization to microorganisms in the building environment. However, detection of specific microorganisms associated with an outbreak is often quite difficult. Growth of such microorganisms in a building is usually favored by a wet environment, and often the source of the causative microorganisms is an air conditioning or humidification system. Environmental evaluation of these outbreaks is quite complex because of the variety of microorganisms which may be associated with the disease, the intermittent nature of some of these outbreaks, and our lack of knowledge about the

health effects of microbial contamination of building environments and the lack of appropriate guidelines for controlling these outbreaks. NIOSH has recently conducted considerable research toward the development of better methods for assessing contamination in these work environments. However, control of the contamination problems in buildings where outbreaks of hypersensitivity pneumonitis have occurred has been quite difficult. In one building complex, for example, several million dollars has been spent in an attempt to alleviate a hypersensitivity pneumonitis problem. At this time it is unclear to what extent this effort has been successful. This underscores the need for better methods to assess and prevent these outbreaks.

5. Contamination from Chemicals Used in Building Maintenance: In a few evaluations, we have been able to relate contamination in a building to substances used in building maintenance. For example, carpet cleansing agents may cause eye irritation and other symptoms in exposed office workers. Agents added to the building's humidification system (amine chemicals) have caused dermatitis and eye irritation. Pesticide use may also cause symptoms in building occupants.

6. Inadequate Ventilation: In over half of our indoor air quality investigations, we have found that the major cause of the problem is inadequate ventilation of the building. The symptoms experienced by office workers in these buildings are usually non-specific, but they are notably similar from building to building and include headache; eye, nose, and throat irritation; fatigue; and in some cases, dizziness and nausea. The illness experienced by many of these workers is severe enough to result in lost work-time, reassignment, and even termination of work. Although complaints usually originate in one section of a building, questionnaire surveys of the building occupants usually reveal that the symptoms are widespread, affecting both professional and non-professional workers.

Because of the highly emotional nature of many of these situations, the complexity of the buildings, and the fact that environmental monitoring may be inconclusive, the results of the investigations are often quite difficult to interpret.

Although more serious illnesses (cancer, heart attacks, etc.) are occasionally attributed to working in these building environments, no clear evidence of health problems more serious than apparent allergic reactions in a few individuals to specific office contaminants has been found. However, our studies have not addressed the question of whether there are long-term health effects associated with working in these environments. Nearly all or our studies have been short term and have been limited to a particular office environment.

In situations in which there is widespread reporting of non-specific symptoms, no specific sources of environmental contamination, and the generally low concentrations of contaminants found in our environmental monitoring, we have usually concluded that inadequate building ventilation is the cause of the employees' complaints. Often, for energy conservation reasons, the amount of fresh air being introduced into the office environment has been limited. In some cases, almost no provision for introducing fresh air has been made. Seasonal cooling or heating requirements often lead to intermittent reduction of fresh air through the building ventilation system. The design of the building, or modifications made to the building after construction, may also interfere with the distribution of fresh air into certain work areas.

Although only low levels of specific contaminants may be identified by the environmental monitoring, we believe that the cause of symptoms in these situations is the buildup of low levels of multiple "natural" building contaminants, including off-gasing from building materials, emissions from office machinery, and solvents and other chemicals used in office work and building maintenance. Inadequate ventilation in the building does not provide for the exhausting of these contaminants. Undoubtedly, cigarette smoke plays a role in increasing the contamination of the office air and in producing symptoms in smokers and exposed non-smokers. Overcrowding in the office may also aggravate the problem.

Unfortunately, we have not identified a specific chemical contaminant, the concentration of which would allow us to say that more ventilation is needed for these buildings. For evaluating the adequacy of building ventilation, our investigators use the ASHRAE (American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc.) guidelines, "Ventilation for Acceptable Indoor Air Quality." These guidelines recommend a minimum of 5 cubic feet per minute (cfm) of outdoor air per person in an office area. The recommended minimum is increased to 20 cfm if smoking is permitted in the office. I will not go into details on these guidelines, because I understand that this was discussed at yesterday's hearings. However, I would like to point out that there has not been a systematic study to demonstrate that following these ventilation guidelines will prevent the development of the type of symptoms reported in our investigations.

Nevertheless, we usually cite these standards in our reports as a guideline for improving the ventilation in buildings where we have found this type of problem.

Thus far in my testimony, I have described CDC research and investigations related exclusively to indoor air pollution in the workplace. CDC has also initiated research that includes nonoccupational exposures to indoor air pollution.

In 1982, CDC's Center for Environmental Health (CEH) conducted a survey of State health department programs for hazard evaluations of nonoccupational indoor air pollution. The survey included questions regarding the type of State programs established to deal with this problem, the appropriate contacts within the State for responding to the problem, and a section on State evaluation of complaints related to presumed exposure to formaldehyde. Responses were obtained from each of the 50 States, the District of Columbia, the City of New York, Puerto Rico, and the U.S. Virgin Islands. The results of this survey are to be sent to the States very shortly.

Survey results you may find interesting are: Of the 50 States and the District of Columbia, (1) thirty-two (63%) have a specific program or person(s) responsible for nonoccupational indoor air pollution; (2) twenty-eight (55%) can evaluate formaldehyde exposures; and, (3) forty-seven (92%) have no existing or proposed nonoccupational indoor air pollution exposure standards. Other information obtained in the survey relates primarily to questions of sampling capabilities, sampling and analytical techniques, and use of data. The results underscore the wide range of State capabilities in this area, and the diverse programmatic responses to a commonly occurring exposure hazard such as formaldehyde. The identification of the responsible program component for indoor air pollution activities within each State health department gives us a valuable list of contacts with whom technical information and guidance on air pollution issues can be exchanged.

NIOSH and CEH are attempting to develop guidelines that can be used by others for investigation of building related air pollution problems. NIOSH is developing practical recommendations for controlling the hazards (e.g., reduce the microbial contamination and increase ventilation), and working to disseminate this information to other groups concerned about indoor air pollution.

In response to your request for suggestions for further research in indoor air quality, I would like to outline three major, interrelated needs:

1. Better Methods of Assessment: Better methods to assess indoor air quality are needed to identify indoor air hazards. NIOSH has done considerable work in assessing chemical and microbial contamination in "problem" buildings, but we do not believe that adequate methods are yet available. For buildings where we attribute the problem to inadequate ventilation, contaminants responsible for causing symptoms in exposed workers need to be identified and appropriate methods developed for their assessment and control.

2. Epidemiological Studies: Careful epidemiological and medical studies need to be done in buildings to determine the prevalence and incidence of symptoms and other medical conditions in relation to the building environment. For both buildings with inadequate ventilation and buildings with outbreaks of hypersensitivity pneumonitis, careful followup environmental and epidemiological studies need to be done to determine to what extent corrective actions have actually improved the health of the building occupants and to determine what, if any, long-term health effects there may be. Such studies could provide the basis for better guidelines to controlling these problems.

3. Control Methods: Research needs to be done to determine how changes in a building ventilation system may affect exposures to building contaminants, such as asbestos or microorganisms. Research is also needed to develop better methods for controlling exposures to other office contaminants at their sources.

Thank you for the opportunity to describe our indoor air quality activities. I will be happy to answer any questions.

Indoor air quality — the NIOSH experience

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Introduction

Health complaints associated with poor indoor air quality have been reported with increasing frequency among office workers over the past 10 years. A number of factors have contributed to this trend, including changes in building design to increase energy efficiency, introduction of new building materials, and increased awareness among workers of potentially toxic exposures in their work and home environments. While some exposures in the indoor environment may have serious implications for the health of the occupants (e.g., radon daughters, asbestos, formaldehyde, pathogenic microorganisms, allergens), the health risks of most indoor air exposures are poorly understood. Nevertheless, office workers who are concerned about a possible problem in their work environment often demand a thorough investigation of the environment and of its potential for health risks. For the investigator, this is commonly a challenging but frustrating experience because of the lack of guidelines and evaluation criteria for the "non-industrial" setting.

The health complaints reported by the occupants of the typical "problem building" are usually diverse and non-specific, and rarely point to an obvious cause. Also, the nature of the problem may be obscured by reports of a variety of serious, but unrelated, medical conditions associated with the office environment.

Appropriate environmental sampling is often quite difficult because of the presence of low levels of many ubiquitous substances. Specific contaminants from sources in the office can be readily measured and quantitated (e.g., ozone from copying machines), but more often very low levels of a variety of chemicals are detected. Such sampling results may in one sense be reassuring, but they have limited usefulness when linked with non-specific symptoms. These investigations are often complicated by extensive media coverage, multiple earlier investigations by other groups, and deteriorating labor relations. The "Federal expert" often comes into the picture when, despite much basic work having been done, the situation has reached a "crisis."

This paper will briefly present and review the indoor air quality investigations conducted by the National Institute for Occupational Safety and Health (NIOSH) since the start of the Health Hazard Evaluation Program. These investigations are being presented not as "THE WAY" to evaluate such problems, but, rather, to review our experience and share our insights as we have evolved our approach to these investigations.

Indoor air quality health hazard evaluations

Through December 1983, NIOSH has completed 203 Health Hazard Evaluations involving indoor air quality (IAQ) in a variety of settings (Table I). (This does not include our investigations of asbestos-related problems in office buildings.) Prior to 1978, only six IAQ evaluations were performed; however, since then, the number has increased dramatically. It appears that in the last 2 years, the number of these completed investigations has leveled off, but this change may reflect our handling of many IAQ inquiries by providing written materials and phone consultation, and by the increased capability of state and local health de-

TABLE I
Completed NIOSH Indoor Air Quality Investigations by Year (through December 1983)*

Year	Number Completed	%
Pre-1978	6	3.0
1978	9	4.4
1979	12	5.9
1980	28	13.8
1981	80	39.4
1982	44	21.7
1983	24	11.8
Total	203	

* Does not include 81 currently active projects

partments and other groups to handle these evaluations without our assistance.

Most of our evaluations have involved government and private offices (over 75% [see Table II]), educational institutions (14.8%), and health care facilities (9.3%). Given our mandate to evaluate occupational health problems, it is not surprising that NIOSH has not investigated very many residential IAQ problems. Thus, we do not have much experience in evaluating problems which are principally encountered in residential buildings such as exposures to radon daughters or to combustion products.

In reviewing the reports on these evaluations, we have attempted to classify our findings by the type of problem found (Table III). It is of note that nearly half of these investigations have attributed the IAQ problems to inadequate ventilation. Some form of environmental contamination was thought to be the source of the problem in approximately 30%. The source of this contamination was thought to be from inside the building in 17.7% of the investigations, outside the building in 10.3%, and from the building structure in 3.4%. Problems such as hypersensitivity pneumonitis, cigarette smoking, humidity, etc., have accounted for approximately 10% of our evaluations. Finally, in another 10%, the etiology of the IAQ problem has remained unexplained.

In reviewing these results, several factors should be considered. First, over time, NIOSH has not used a standard protocol for conducting these evaluations. Our methods and criteria have changed as we became more familiar with the problem and developed new approaches. Also, some of these investigations were conducted several years ago, leaving only scanty data and a brief report for current review. In the early studies, many of the "unknown" problems may have actually been due

TABLE II
Completed NIOSH Indoor Quality Investigations by Building Type (through December 1983)

Type	Number	%
Government and business officer	154	75.9
Schools and colleges	30	14.8
Health care facilities	19	9.3
Total:	203	

TABLE III
Completed NIOSH Indoor Air Quality Investigations by Type of Problem (through December 1983)

Problem	Number	Total
Contamination (inside)	36	17.7
Contamination (outside)	21	10.3
Contamination (building fabric)	7	3.4
Inadequate ventilation	98	48.3
Hypersensitivity pneumonitis	6	3.0
Cigarette smoking	4	2.0
Humidity	9	4.4
Noise/illumination	2	1.0
Scabies	1	0.5
Unknown	19	9.4
Total:	203	

to inadequate ventilation, but the reports did not provide enough information to determine this. Thus, there may be considerable misclassification in this list.

This listing is also not necessarily representative of the general distribution of indoor air quality problems in offices. Often, NIOSH is requested to conduct an evaluation only after initial attempts to identify the problem have failed, or complaints have persisted after initial corrections have been made. Large public-sector agencies use NIOSH as a resource, but managers of smaller offices or office buildings may be unaware of our program. Therefore, these facilities may be underrepresented on our list. Despite these shortcomings, the list does provide an overview of the types of indoor air quality problems encountered in office environments. A brief review of the major types of IAQ problems follows.

Contamination from inside the office environment

This classification (approximately 18%) refers to exposure to a chemical or other toxic agent generated within the office space. Usually the symptoms experienced by the office worker are directly linked to the exposure, but, if the exposure is disseminated through the building's ventilation system, localization of the source may be difficult. Examples from Health Hazard Evaluations include exposures to methyl alcohol from spirit duplicators,[1] exposures to methacrylate from copiers,[2]

and exposures to sulfur dioxide from a heating system.[3] Occasionally, a very specific health effect can aid in the investigation, such as the occurrence of dermatitis from amines used in humidification systems.[4,5] The use of pest control agents, such as chlordane, may also cause persistent problems in office environments.[6,7]

These problems can usually be identified by inspecting the affected office area (e.g., copying machines) and by questioning about other uses of chemicals in the building (e.g., pesticides, humidification agents). Environmental and medical testing appropriate for that chemical can then be conducted.

Contamination from outside the building

This classification (approximately 10%) refers to exposure to a chemical or other toxic substance originating from a source outside the building. Common examples include motor vehicle exhaust either from a parking garage or loading dock entering the building through the intake from the ventilation system.[8,9] Many of these exposures are "presumed" explanations that cannot be documented at the time of the investigation. Although the dispersal of substances through the ventilation system may seem obvious, the complexity of the system may require the use of more sophisticated techniques such as a tracer gas to document the problem.[8] Other outside sources include nearby construction activity which may generate sufficient exhaust fumes, dust, or other contaminants to cause complaints in nearby offices.[10]

A few years ago, NIOSH evaluated a dramatic case of outside contamination of an office building when we discovered a 6-million-gallon underground gasoline spill while investigating irritative symptoms among the office occupants.[11] While this may be viewed as unusual, there is concern about the increasing number of underground gasoline tank leaks.

Contamination from the building fabric

Contamination from the building fabric (approximately 3% of our evaluations) refers to problems from the material used to construct the building. While not included in our list of evaluations, asbestos is obviously a major source of concern about indoor air quality. Other insulating materials are a common source of these problems because of the release of substances such as formaldehyde.[12] Dermatitis due to fibrous glass has also been a common problem, usually after the fibrous glass insulation has been disturbed during some construction activity.[13]

Hypersensitivity pneumonitis

This group (approximately 3% of our evaluations) refers to problems due to a hypersensitivity reaction to microorganisms in the building environment. Although not a common cause of office problems, the potential medical severity of this condition and the difficulties in controlling this problem make it an important cause of office problems. NIOSH's evaluations regarding this problem will be discussed later in this volume.

Inadequate ventilation

By far the largest classification, this group makes up approximately one-half of our completed evaluations. Our determination of inadequate ventilation is commonly made after considering a number of factors, including the absence of other sources of contamination and the presence of only very low levels of contaminants in our environmental sampling results. These, linked to the widespread occurrence of non-specific symptoms such as headaches, eye irritation, and upper respiratory irritation, suggest that an evaluation of the ventilation system may be warranted.

The evaluation of ventilation systems will be discussed later. Our methods range from obtaining specifications on the building ventilation system to detailed air flow measurements. Both approaches can present difficulties. Information on the specifications of the ventilation system is often not readily available from the building operators. Buildings with renovated ventilation system are often very difficult to evaluate because of the piecemeal approach used in such renovation. The ASHRAE guidelines for ventilation are usually used for comparison.[14] While one can question the basis for these guidelines, we have found them useful in evaluating IAQ problems and for recommending corrections where there is a problem because of inadequate ventilation.

The pathogenesis of complaints or symptoms caused by inadequate ventilation is not clear, but certain extreme situations have provided us with some insight into the relationship between such complaints and inadequate ventilation. In 1982,

we conducted an evaluation at a government office building in Idaho with widespread complaints among the employees. Despite environmental surveys showing no significant contaminant levels, the employees were moved to another building. Our investigators found that the air intake for the building had been covered with plastic one year earlier, to protect the air handling system from airborne debris from Mount St. Helens, and that this cover had never been removed. Removal restored intake of adequate outdoor air to the building and allowed reoccupancy without significant problems.[15] However, in this situation, no environmental measurement indicated that there was a problem. In general, we have not found any environmental measurement to be useful as an indicator of poor ventilation. However, it should be noted that other investigators have found carbon dioxide levels useful for such evaluations.[16,17] Low levels of multiple contaminants are often present in these situations and are currently the best explanation for the occurrence of symptoms. The pattern of contaminants probably varies from building to building, but we do not yet have adequate measurement techniques or adequate knowledge to easily recognize this problem through environmental sampling.

Current evaluation methods

Our current approach to evaluating office environment requests usually begins with a walk-through evaluation by an industrial hygienist. Prior to this, we try to obtain background information on the history of the building design or construction and try to ensure that the building engineer will be present during the investigation. During the initial visit, we obtain a history of complaints among office occupants by interviewing as many as is feasible. This is helpful not only for identifying the type of medical complaints, but also for obtaining a chronology of the problem and ascertaining the time pattern of symptoms (afternoon more than morning, etc.).

Potential sources of contamination are identified during the initial walk-through evaluation. Some will be obvious (e.g., copying machines), while others may be identified only after careful questioning (e.g., pesticide spraying). We also usually inspect the ventilation system for the particular office area and attempt to understand its connection to the system for the entire building. Information on the control of the ventilation system (outdoor air intake relative to temperature, etc.) is also obtained. Some environmental sampling may be conducted if a source of contamination is found or suspected. Some general air monitoring (e.g., organics) may also be conducted, but this is usually more helpful to reassure the occupants that the toxic substances of concern to them are not present in any degree than it is for identification of a problem.

The problem may be resolved during this initial visit, but, in some instances, more extensive environmental sampling, a medical study, a ventilation assessment, or some combination of these may be required. These may be necessary either to better identify the source and extent of the problem or to alleviate the concerns of the affected employees. Once our investigations are complete, our findings and recommendations are communicated to the involved parties.

Future activities in indoor air quality

More research into office ventilation and its effect on background levels of contaminants is necessary to provide better guidelines for evaluating and controlling indoor air quality problems. Because of the nature of these exposures, a variety of governmental agencies and private groups are involved in this research effort. Recently, the Environmental Protection Agency, the Consumer Product Safety Commission, the Department of Energy, the Department of Health and Human Services, the Tennessee Valley Authority, and several other Federal agencies formed a coordinating committee on indoor air quality research. This committee will help to coordinate Federal government indoor air quality research. Already, an inventory of IAQ-related research in the Federal government has been prepared. These agencies are also coordinating the planning of a possible large national survey of indoor air pollution and related health problems.

While much of this effort and related research may seem remote to investigating specific problems in office buildings, they may provide the basis for better guidelines for evaluating indoor air quality and for necessary corrective steps. At the same time, improved methods of assessment are needed to evaluate specific types of problems.

NIOSH is currently developing better methods for assessing indoor air quality (e.g., microorganism levels, ventilation parameters, etc.). Other groups are working on methods for other types of assessments. Meanwhile, we will continue to evaluate indoor air quality problems and, hopefully, continue to improve our efforts in these assessments.

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Am. Ind. Hyg. Assoc. J. 47(4):207-213 (1986)

Evaluation of Building Ventilation Systems

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Over the past several years, NIOSH has responded to health hazard evaluation requests from workers in dozens of office environments. Typically, the employees have complained of headache, eye and upper respiratory tract irritation, dizziness, lethargy and the inability to concentrate. Most often "inadequate ventilation" has been blamed for these complaints. Of paramount importance in the evaluation and correction of these problems is an effective evaluation of the building's ventilation system. Heating, ventilating and air-conditioning conditions that can cause worker stresses include: migration of odors or chemical hazards between building areas; reentrainment of exhaust from building fume hoods or through heat wheels; buildup of microorganisms in the HVAC system components; and poor odor or environmental control due to insufficient "fresh" outdoor air or system heating or cooling malfunction. The purpose of this paper is to provide an overview of building ventilation systems, the ventilation problems associated with poorly designed or operating systems, and the methodology for effectively evaluating system performance.

Introduction

Man has constructed buildings to protect himself and his possessions from the elements. Enclosures, however, may not protect man from various sources of pollution. Sterling and Kobayashi[1] have reviewed studies on pollution in enclosed living and working places and have come to the following conclusions: "Buildings do not protect their inhabitants from pollution. To the contrary, the body burden of toxic vapors and dusts in the 'inside' may very well exceed the burden of pollution in the 'outside'."

Pollutants in an office-type environment may arise from multiple sources: human metabolic activity, smoking, structural components of the building, biological contamination, cooking, office equipment and outside air pollution.

Metabolic activity produces a variety of by-products: carbon dioxide, water, feces, flatus, urine, breath, sweat, glandular secretions and organic dust particles from hair, skin, mucus and dead cells. From breath come acetic acid, acetone, volatile oils, methane and hydrogen sulfide; from urine come volatiles, ammonia and ethereal sulfates; from sweat and glandular secretions come urea, lactic and other organic acids.[1]

In studies of smoking in test rooms and in public buildings, measureable (and in some cases excessive) levels of particulate matter, carbon monoxide, nicotine, acrolein, acetaldehyde and benzo(a)pyrene[1] have been found.

Materials of construction have been shown to cause measurable levels of contamination in office environments. Formaldehyde can be released from urea formaldehyde insulation materials. Low vapor pressure solvents may evaporate over extended periods of time from paints and adhesives.[1]

Air conditioning and heating systems can become contaminated with many types of microorganisms. Then these systems in turn pollute the indoor environment with these microorganisms.[2,3]

Cooking is a major source of hydrocarbons and particulate matter. Gas appliances also can produce carbon dioxide, carbon monoxide and nitrogen oxides.[1]

A typical office may use equipment which may liberate other contaminants; *i.e.*, mimeograph machines — methyl alcohol; blueprint machines — ammonia; office copiers — ozone, toner chemicals.[1]

Tight Building Syndrome

Public and private residential and commercial buildings consume about one-fourth of the total end-use energy produced in the United States. Thus, increasing attention has been directed to the design of new structures and the modifications of existing ones to minimize the consumption of energy.

Typical energy reduction strategies include:

1. Modification of the chiller cycling to operate equipment near capacity;
2. Reduction of the outdoor air component of the office supply system to a minimum;
3. Reduction of the total air circulation to the minimum value needed to maintain design space ventilation conditions;
4. Elevation of cooling coil discharge temperature with a concurrent increase in relative humidity at the design room temperature;
5. Periodic shutdown of ventilation system components.[4]

Energy reduction strategies also may include use of sealed windows, lower winter and higher summer room temperatures and centralized control of air conditioning, heating and lighting. These strategies may give office employees the feeling that they are not in control of their work environment.

Over the past several years, NIOSH has conducted health hazard evaluations in response to requests from workers in numerous office environments.[5-7] Typically, the employees have complained of headache, eye and upper respiratory tract irritation, dizziness, lethargy and the inability to concentrate. Most often "inadequate ventilation" has been blamed for these complaints. In the majority of these cases, measurements for airborne contaminants have failed consistently to identify toxic contaminants as a probable cause

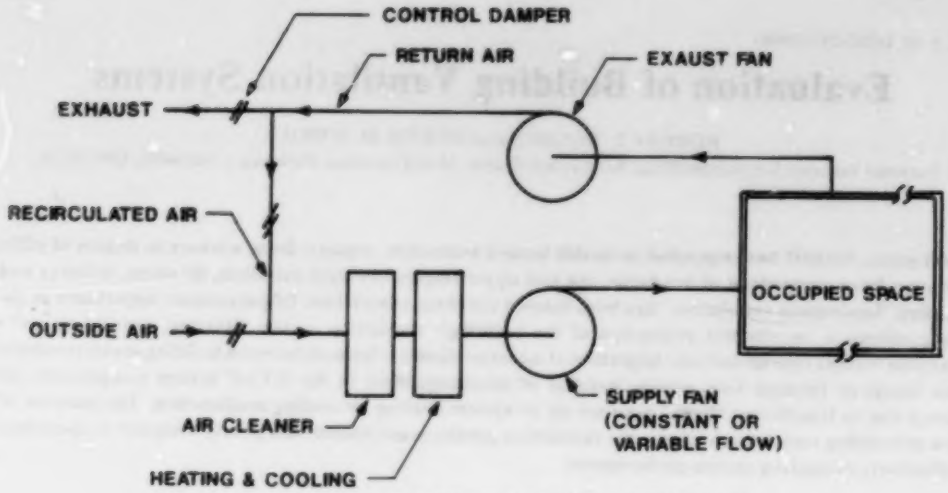


Figure 1 — Constant or Variable Air Volume HVAC System.

for employee symptoms; NIOSH investigators repeatedly have documented insufficient (or total lack of) fresh air in these same environments. Extremes in temperature and relative humidity have been noted also.

Of paramount importance in the evaluation and correction of these problems is a thorough analysis of the building's ventilation system. The purpose of this document is to provide an overview of building ventilation systems, the ventilation problems associated with poorly designed or poorly operating systems and the methodology for effectively evaluating system performance.

Heating, Ventilating and Air Conditioning (HVAC) Systems

There are three basic types of heating, ventilating and air conditioning (HVAC) systems: the all-air system; the air and water system; and the all-water system.[8]

All-Air Systems

All-air systems may exist as large central units serving an entire building or small unitary systems serving small areas or zones within a building. These systems heat or cool the air at a central location and transmit it to the room(s) as indicated in Figure 1. The air may be tempered to the desired condition and transmitted through a single duct or hot and cool air may be transmitted separately *via* a dual duct system and appropriately mixed just prior to discharging into the room. A dual duct system is illustrated in Figure 2. All-air systems may be further classified as constant air volume (CAV) or variable air volume (VAV). The CAV system is operated at a fixed flow rate and varies the temperature only. The VAV system operates in the same manner relative to the heating, cooling and transmission of air, but has the additional capability of varying the air volume as well as temperature depending upon the space heating or cooling load.

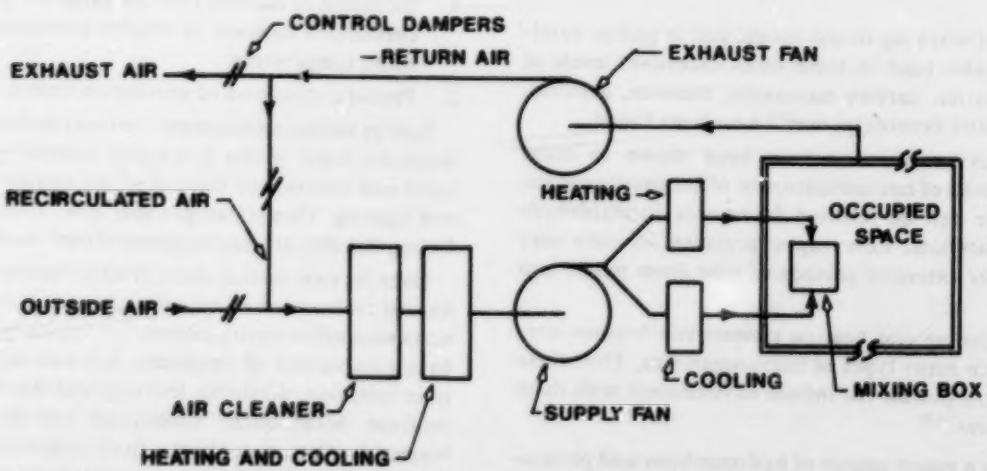


Figure 2 — Constant Air Volume Dual Duct HVAC System.

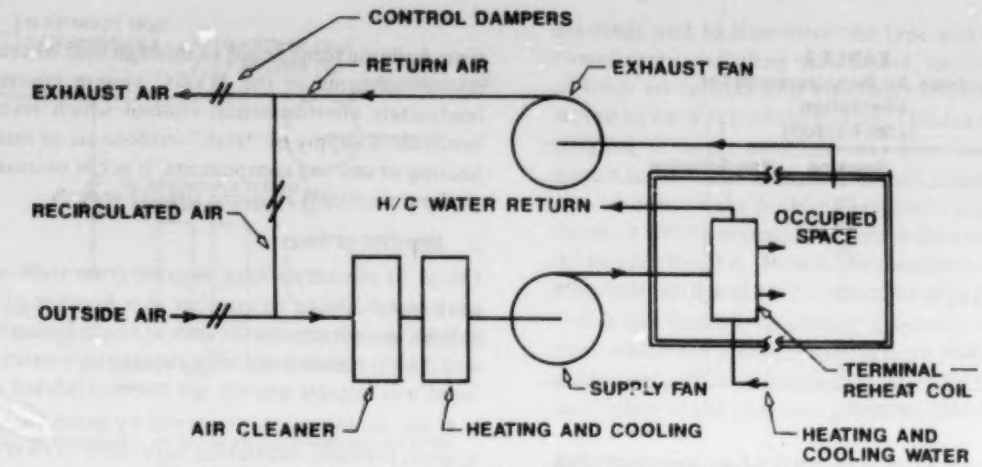


Figure 3 — Terminal Reheat Constant Volume HVAC System.

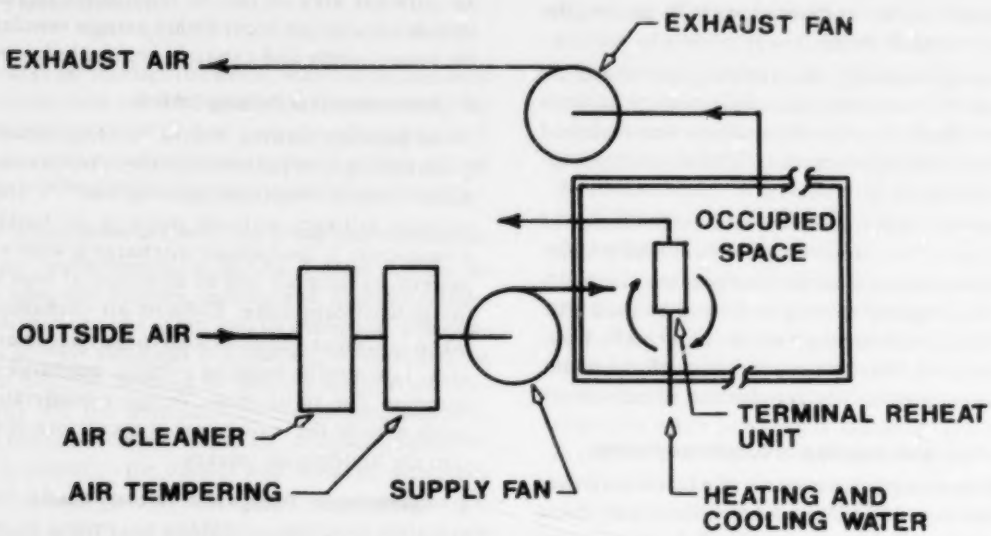


Figure 4 — All Water HVAC System.

Both systems can utilize outside air to assist in temperature control and to assure that an appropriate amount of outside air is circulated throughout the building. In limited cases, the entire airflow may consist of outside air (single pass system). Most systems, however, will incorporate recirculation of the return air as an energy conservation feature. The quantity of outside air in recirculated air systems can vary from 10% (which may approach the minimum required for odor and contaminant control) to 100% of the system supply flow. The actual quantity is determined by the indoor/outdoor air temperature relationship and in many cases by the overall energy conservation requirements.

Air and Water Systems

Air and water (also known as terminal reheat) systems are similar to the single duct all-air systems described previously. Before discharge into the room, however, the air passes through a terminal (fan coil) unit supplied with heating/cooling water. A typical system is depicted in Figure 3. Some initial heating or cooling may be performed. Like all-air systems, these systems typically recirculate a portion of the building air.

All-Water Systems

All-water systems normally use a number of self-contained fan coil units (same as terminal retreat), which distribute heated or cooled air to the work space. Unlike the air and water systems, all of the heating or cooling airflow is recirculated from the work space. Outside air still is required for ventilation and is introduced through a separate duct system with some initial tempering. A schematic of a typical all-water system is shown in Figure 4.

All three types of HVAC systems may incorporate humidification and dehumidification operations. Dehumidification usually will be required during the cooling season and

TABLE I
Outside Air Requirements for Ventilation[1] (cfm/Person)

	Smoking	Non-Smoking
Office space	20	5
Meeting space	35	7
Classrooms	25	5
Libraries	-	5
Hospital operating room	-	40
Photo dark room	-	20
Retail store show room	25	5
Dry cleaning storage area	35	10

[1]From ASHRAE 62-1981 Table III.

normally is accomplished at the system cooling coils. Conversely, humidification usually is required during the heating season. Humidification typically is performed by spraying water or steam into the supply airflow, or by passing the air through water-soaked media.

Air-moving systems usually incorporate filtration for the removal of dust particles but also may include charcoal beds for odor control. Particle removal usually is accomplished by fabric filtration although some use of electrostatic precipitation may be found.

Actual system configuration may be a combination of more than one type. The systems described are used primarily for environmental control of the core portion of a building. Perimeter heating and cooling units may be used also. These may be small individual steam or water units occasionally incorporating fans to circulate air with the room. Some of these units provide for introduction of outside air.

HVAC System Problems Relating to Employee Health

HVAC problems may be an adverse impact on employee health and well-being. HVAC conditions which may cause worker stresses include: migration of odors or chemical hazards throughout the building; reentrainment of exhaust from building fume hoods or through heat wheels; buildup of microorganisms in the HVAC system components; and inadequate environmental control which results from an insufficient supply of "fresh" outdoor air or malfunctions in heating or cooling components. It is not unusual for several of these problems to occur simultaneously.

1. Migration of Odors

Odors or chemicals may migrate from their origin in one part of a building to another in a number of ways. If the HVAC system serving the area of origin is common to others and if air is recirculated (as is the common case), the contaminant will migrate quickly *via* the recirculated air.

If the building area is served by more than one HVAC system, pressure imbalances may occur between zones. This will cause air to move from the higher pressure zone into the lower pressure zone. The movement may be from one area to an adjacent area or can be from floor to floor. Pressure imbalance also can occur within a single ventilation system if the room supply and exhausts are not balanced properly.

2. Reentrainment of Building Exhaust

Wind currents flowing over a building create a turbulent recirculating flow pattern over the roof area and a turbulent wake on the downstream building side.[9,10] The size of these patterns will vary with the shape of the building, but they always exist. If the exhaust discharge is within the roof flow pattern, exhaust air will be dispersed at roof level and into the downstream wake. Exhaust air contaminants may be taken into any air inlet located in the recirculation and wake area. Low profile building exhaust discharge and inlets are common due to aesthetic design considerations. The net result may be the inadvertent recirculation of contaminants into the building air intakes.

3. Reentrainment Through Heat Recovery Wheels

Heat recovery wheels absorb heat from discharge air and transfer it to incoming air. They function by passing the

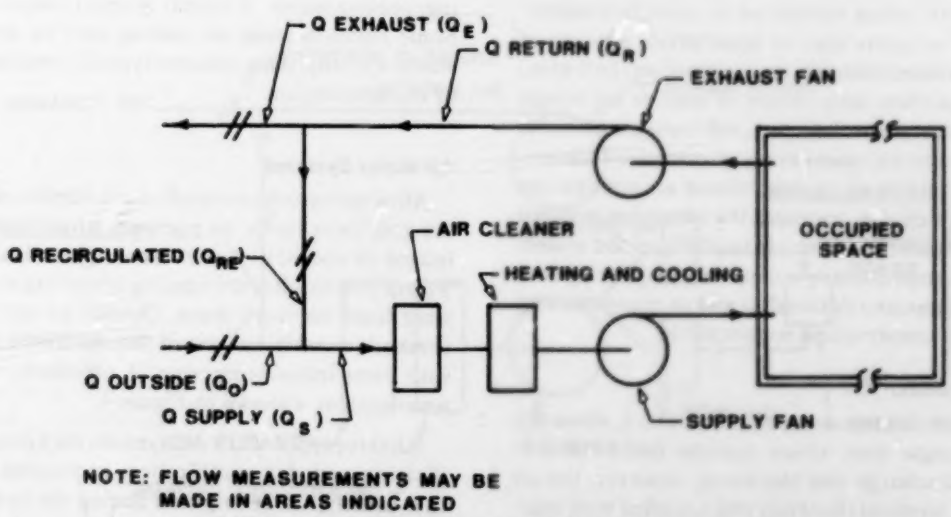
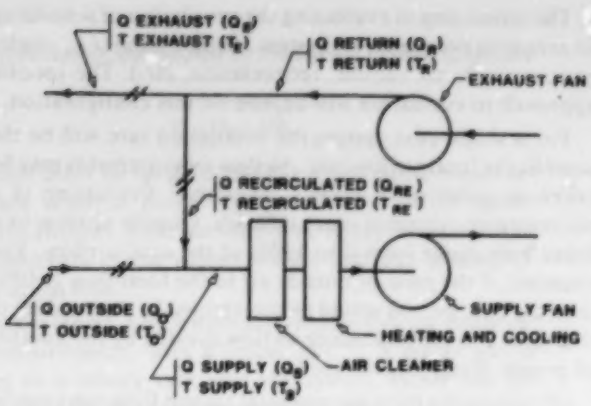


Figure 5 — HVAC System AirFlow Measurement.



NOTE: $T_R = T_E = T_{RE}$ IF MEASURED AT OR NEAR AIR HANDLING SYSTEM

AND % OUTSIDE AIR = $\frac{Q_O}{Q_S} \times 100$

Figure 6 — Determination of Outside/Supply Air Rates by Temperature Measurement.

heated discharge air through the wheel, which is packed with a heat absorbing material. The wheel rotates permitting the cooler incoming air to pick up heat from the wheel material. Contaminants may be transferred to the incoming air *via* leakage or carry-over in the wheel heat absorbing material.

4. Poor Odor or Environmental Control Due to Insufficient Ventilation

There are two requirements for HVAC system airflow: to provide for adequate heating, cooling and humidification (or dehumidification) of a space and its occupants and contents and to provide sufficient outdoor air for odor and/or contaminant control. Heating or cooling airflow requirements usually are the dominant consideration, and it is common to recirculate most of the air. A small fraction of the airflow is vented to the outside and replaced with fresh air to prevent a buildup of odors or other air contaminants. Malfunction of system inlet dampers, improper settings or poor initial design can reduce the volume of outside air below requirements needed for control of odor and contaminants. This problem may be difficult to identify as the total airflow into the space may appear to be sufficient.

5. Microorganisms as Contaminants in HVAC Systems

Practically all HVAC systems will incorporate filtration, dehumidification and humidification to some degree. Filter media are composed of fabric or fibrous materials. These materials can harbor microorganisms if not kept clean and moisture-free. Water from humidification systems may drain into sumps within the system. If not treated or replenished adequately with fresh water, biological growth may occur. Dehumidification systems, while removing water from the air, incorporate drain pans which may become contaminated and cause similar problems. In all cases these microorganisms may be carried into the occupied building space by the ventilation air.

Evaluation of HVAC Systems

The first step in evaluation of a system is to obtain design drawings and to determine the type and configuration of components, including the number, location, type and size of fresh air intakes and building exhausts, and the areas served by each part of the system. This may be difficult if the building is large, modifications have been made, or the system is otherwise complex. In such cases, it may be necessary to consult the building architect/engineer. As a minimum, it will be necessary to define the system with relation to the problem, *i.e.*, How is the suspected (or actual) source area ventilated and how is the complaint area ventilated?

It is not feasible to provide a specific evaluation procedure, which will provide answers to all problems; instead, the guidelines presented below should enable the reader to evaluate many of the common problems described earlier.

Reentrainment of Air From Building Exhaust

Reentrainment problems usually manifest themselves by detection of odors or contaminants in an area remote from the source. If there are a number of inlets, detection in any number of areas may occur with shifts in the wind direction.

Evaluation can be accomplished by one of two procedures. In both cases, the physical characteristics of the exhaust and intake systems must be determined. Specific attention should be given to the perceived migration path of the contaminant. Where does the alleged contaminant originate? Where is it exhausted? Where is the air intake serving the complaint area located?

Release of smoke (by use of a smoke candle or grenade) in the discharge stack can provide visual evidence of the flow path. This method is not quantitative, but in many cases can identify the problem. A tracer can be released at a known rate into the exhaust system in the source area with measurements taken at a supply discharge grille or supply point in the detection area. If the tracer is present, it confirms the reentrainment. By knowing the tracer release rate and the airflow rate, the tracer concentration in the exhaust air can be calculated. By comparison of this value to the concentration in the detection area supply air, the dilution of the exhaust contaminant can be determined. Detection of the tracer in the supply air will verify reentrainment; determination of the relative concentration will quantify the severity.[11,12]

Sulfur hexafluoride (SF_6) has been used as a tracer gas. It is chemically inert and is present normally in the environment. Measurements can be made with infrared detection devices or gas chromatography with the use of electron capture detectors. Infrared devices will provide satisfactory results but require rather large quantities of the tracer due to their low sensitivity. Gas chromatography proves more satisfactory by being able to detect SF_6 in concentrations as low as 1 ppb. Other racer materials may be used provided that they are not present normally in the areas of concern and detection instrumentation is available.[11]

Migration Within a Building

Migration of odors or contaminants within a building is caused by differences in pressure between building areas

Unfortunately, equal pressures are difficult to maintain in multi-story and multi-area buildings, especially when more than one ventilation system is used. In certain cases such as laboratory buildings, pressure differentials serve useful purposes by containing contaminants within the low pressure area.

To evaluate possible migration of air contaminants, it is first necessary to determine the physical characteristics of the building ventilation system(s). The existence of pressure differentials can be determined by use of smoke tubes at doors and hallways. The direction of smoke travel will be in the direction of higher to lower pressure. This method provides more of an indication of migration than a quantitative assessment. The use of a tracer gas also can provide accurate documentation of a contaminant migration. Here the tracer would be released into the room air in the source area while sampling is conducted in other building areas.

Reentrainment Through Heat Recovery Wheels

Contaminants may be transferred to an incoming air stream *via* leakage or carry-over in the wheel heat absorbing material. Contamination through leakage can be evaluated by use of the tracer gas technique. The tracer is released in the exhaust air inlet to the heat wheel and measured in the heat wheel outside or make-up air discharge duct. Comparison of the mass flow of the tracer in the two ducts can provide a quantitative measure of the problem.

Insufficient Outside Air

Fresh (outside) air ventilation rates are recommended by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHR AE62-1981)[13] for occupied spaces (Table I). For example, 20 cfm per person is recommended where there is smoking, and 5 cfm per person where there is no smoking. These rates are designed to provide for normal odor and contaminant control. These flow rates usually are much lower than the airflow required for heating and cooling. If the HVAC system does not recirculate, the supply air will be from the outside and the ventilation rules should be satisfied. Single pass systems, however, are outnumbered greatly by HVAC systems which recirculate return air directly to the supply side inlets. Provision for outside ventilation air then must be incorporated into the system. This usually is accomplished by a series of dampers as diagrammed schematically in Figure 5.

The level of recirculation usually is dependent upon the indoor/outdoor temperature relationship. One typically observes higher levels of recirculation when the temperature difference is great and lower when the temperature difference is small. The level of outside ventilation air should not fall below that recommended by ASHRAE. Unfortunately, this minimum level is not always maintained for a number of reasons. The initial design may have not been adequate either in determination of the proper value or in specification of system components. Deterioration or malfunction of system components may have occurred. A final and all too common reason is an arbitrary reduction or elimination of outside air to conserve energy.

The initial step in evaluating the ventilation of a building or area is to determine the system configuration (*i.e.*, single-pass, variable air volume, recirculation, *etc.*). The specific approach to evaluation will depend on this configuration.

For a single-pass system the ventilation rate will be the same as the total airflow rate. Airflow measurements may be taken at grilles or in ducts if accessible. Evaluation of a recirculating system is more difficult. Outside airflow to a space may range from 0 to 100% of the total airflow. For example, if the ratio of outside air to the total flow is 10%, then the cfm/person would be determined by the product of this ratio and the total space airflow divided by the number of people occupying the space.

Obtaining the fresh air and total system flow rates can be difficult depending on the physical complexity of the HVAC system. There are three general approaches that may be used. The first is direct measurement of the appropriate airflows. Such measurements can be made with pitot tubes and/or direct-reading instruments such as hot wire anemometers or rotating vane anemometers. The three principal streams to measure are the outside airflow, the HVAC system main supply airflow and the airflow to the space under investigation. While some buildings will contain well defined ductwork with accessible measurement points, many will not. It may be necessary to measure average velocity over the face of a grille to determine airflow. Duct measurements may be made in any convenient place as long as the measurement represents the total flow of interest. Room air usually will be supplied from grilles or through slots incorporated into light fixtures. Special portable flow measuring hoods for measuring total air volume from various shaped outlets are available commercially which greatly speed these measurements.

In many situations, there may not be sufficient access to permit airflow measurements with standard techniques. Where this occurs a temperature balance may be appropriate. This technique is a thermal energy balance between the recirculated air, outside air and the supply air streams. The sum of the products of the recirculated air and the outside airflows and their respective temperatures should equal the product of the supply air and its temperature. Since the supply airflow is the sum of the recirculated and outside airflows, the percent of outside air in the supply can be calculated.

Referring to Figure 6 shows:

$$Q_{RE}\,T_{RE} + Q_O\,T_O = Q_S\,T_S$$

and

$$Q_{RE} + Q_O = Q_S$$

Solving these equations yields

$$Q_O/Q_S = \frac{T_S - T_{RE}}{T_O - T_{RE}}$$

The percentage of outside air in the supply system therefore equals

$$Q_o / Q_s \times 100.$$

Caution must be used so that the temperature measurements are taken at points that are representative of the respective airflow. Also, the supply air temperature must be taken upstream of the supply blower and any heating or cooling apparatus.

A third method, which does not require flow or temperature measurements, uses a tracer gas.[14] A tracer gas is released at a steady rate into the system, either *via* the outside air or the main supply until a steady state concentration is achieved in the room or area under investigation. Then the release is stopped, and the concentration decay is measured. Then the room ventilation rate is determined from

$$I = \frac{1}{t} \ln \frac{C_o}{C}$$

where I = ventilation rate, (room air changes per hour)
t = time, (hours)
C_o = concentration of tracer at time = 0
C = concentration of tracer at time = t

Biological Contaminants

Evaluation of any HVAC system should include a thorough check of filters and sumps for cleanliness.[2,3] Water draining from the humidification components may stagnate and will often foster the growth of biological contaminants. These systems should be designed to permit complete drainage of the collected water. If the water is recirculated, sufficient replacement must be provided to preclude stagnation. Filters must be checked for cleanliness also since these components may harbor microorganisms and reduce airflow as well. Dirt allowed to collect in ducts and in perimeter HVAC systems can provide the substrate which fosters the growth of microorganisms.

Summary

Evaluation techniques described in this paper help to provide an effective measure of the flow rates and overall performance of building ventilation systems. The tracer techniques described are very effective in determining flow patterns or migration of building contaminants.

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22 October 1984; Revised 19 September 1985

GUIDANCE FOR INDOOR AIR QUALITY INVESTIGATIONS

Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations and Field Studies
National Institute for Occupational Safety and Health

Cincinnati, Ohio 45226

January 1987

This draft guidance was prepared to help you as an employer or employee evaluate or become directly involved in the evaluation of an indoor air quality problem.

The information provided was written in the hope that it would be self-explanatory. If, however, after reading the guidance you have questions, need clarification on any of the information, or would like to further discuss a given issue, feel free to contact one of our industrial hygienists.

We would also appreciate your comments and suggestions about this draft guidance, specifically, if it was helpful or more importantly, if it was not helpful. If you would like to share your comments or suggestions, or have questions, you can contact: Hazard Evaluations and Technical Assistance Branch, DSHEFS, NIOSH, 4676 Columbia Parkway, Cincinnati, Ohio 45226 (Phone 513-841-4374).

FOREWORD

This guidance was prepared by researchers in the Hazard Evaluations and Technical Assistance Branch, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS), National Institute for Occupational Safety and Health (NIOSH). It is based upon our experience in conducting approximately 450 field investigations of indoor air quality problems in many types of buildings. Because indoor air problems have become increasingly common, and because it is more efficient in certain instances for employers and/or employees to evaluate or be directly involved in the evaluation of indoor air problems, we have developed this information to guide employers and employees in this endeavor.

This guidance is presented in three sections:

1. OUR EXPERIENCE: which provides the reader with information regarding our experience with indoor air quality problems and describes some of the most common causes of these problems.

2. SELF-EVALUATION OF INDOOR AIR QUALITY PROBLEMS: a "self-help" approach to assist the reader in evaluating an indoor air quality problem.

3. INDOOR AIR QUALITY CONSULTATION SERVICES: where the reader can go, in addition to NIOSH, for outside assistance if self-evaluation cannot resolve the problem.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

Section I

OUR EXPERIENCE

Since 1971, investigators in the Hazard Evaluations and Technical Assistance Branch have responded to approximately 450 complaints of indoor air quality problems in a wide variety of office settings. The majority of these investigations have been conducted since 1979, paralleling the "energy efficiency" concerns of building operators and architects.

The majority of these indoor air quality investigations are part of the Health Hazard Evaluation Program. We conduct these evaluations upon request, from employee groups, unions, management, and local, state and Federal agencies. Generally, these requests are in response to existing worker health complaints and illness.

In this section, we have summarized our findings from indoor air quality investigations completed since the beginning of the Health Hazard Evaluation Program. Although these findings represent one of the single largest data and information bases that is currently available on the subject, the reader is advised that these findings should not be viewed as a statistically-valid cross section of the indoor air quality problem.

A. METHODS

We have found that investigating indoor air quality problems is not an easy job. These problems can be very complicated due to highly charged emotions, the complexity of the buildings themselves, and the fact that standard epidemiology and industrial hygiene evaluation techniques may be inconclusive.

Over time, we have tried to develop a consistent, solution-oriented approach to conducting these investigations. Our approach is probably best described as one of exclusion, by which we try to eliminate and narrow-down the range of possible problem causes.

Our investigation teams have typically included an industrial hygienist and a physician or non-physician epidemiologist, although other professionals (such as an engineer) have been included as well. Most of our investigations have included: a background assessment; an initial site visit; and follow-up site visits if necessary.

1. Background Assessment

The intent of the background assessment has been to obtain as much historical information as practical on the building itself, (when it was constructed, its fabric type, ventilation system, previous

problems and previous investigations into air quality, recent renovations, etc.). In addition, to establish a chronology of the problems, we also have tried to obtain information about the kinds of symptoms employees have been experiencing and over what period of time. We have collected much of this information by using a questionnaire. Having access to these data prior to the initial site visit has allowed us to develop more effective strategies in dealing with these problems and has promoted more efficient use of investigator time during site visits.

2. Initial Site Visit

For the initial site visit, our typical protocol has been conducted in three separate steps: a walk-through evaluation, personal interviews, and environmental monitoring.

The walk-through evaluation is needed to obtain any additional background information not obtained during the Background Assessment (architectural plans, engineering reports, or previous environmental assessments, etc.) and to gain, first-hand, a visual appreciation for the building's design and floor plan. A critical inspection of the ventilation system is also important in order to thoroughly characterize the building with respect to potential sources of chemical and microbiological contaminants.

The personal interviews are needed to better characterize the building population and to determine the nature of the symptoms and complaints being reported. The personal interviews also have been critical in determining the magnitude of the problem, specifically if the problem is widespread throughout the building, or whether it is isolated in a particular section of the building or among a certain group of employees. In many of these instances, we again have used questionnaires, to collect this information.

On-site environmental monitoring is used to confirm or to rule-out a number of problem source possibilities identified from the background assessment, the walk-through evaluation, and the personal interview portions of the initial site assessment. During the initial site assessment, direct-reading monitoring methods have been most commonly used because they are excellent screening mechanisms that provide us with immediate results and thus, allows us to provide anxious employees immediate feedback. The most common instruments that we have used are: detector tubes for carbon dioxide, psychrometers for measuring temperature and humidity, and smoke tubes for determining air movement. We also, on occasion, have tested for specific chemical and microbiological contaminants, when appropriate. It has been our experience however, that standard industrial hygiene techniques for measuring chemicals may be inconclusive since most contaminants that

we monitor are usually present at concentrations far below those known to cause health-related problems in industry. While this approach may be consistent with our solution-oriented philosophy, we recognize that the capability of substances to cause health effects in trace concentrations is not well understood.

Another limiting factor in understanding what environmental measurements mean, occurs with the Evaluation Criteria that are available to compare findings against, since these Criteria vary. In the classic industrial hygiene sense, the Occupational Safety and Health Administrations's (OSHA) permissible exposure limits (PELs), the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs), and NIOSH's recommended exposure limits (RELs) are most commonly used to assess exposures of workers in factories. Because these criteria are based on health effects that pertain to exposures in the manufacturing environment, they may not have the same relevance for workers in an office setting, whose primary concern may be for comfort or simply an absence of unusual sensory stimuli over their working period. The Environmental Protection Agency (EPA) has ambient air quality standards for a variety of pollutants designed to protect the public over an entire day (not just an 8-hour workday). However, these, too, may not have relevance to an indoor office environment, especially from the perspective of problem-solving.

The American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) guidelines for acceptable indoor air quality have been developed specifically for the indoor environment. We have commonly used these as our guidelines in office building evaluations, especially for assessing the performance of ventilation systems. We also use the ASHRAE comfort guidelines as criteria for assessing the thermal performance of occupied space.

In addition to the ASHRAE guidelines, we use "rule-of-thumb" measures gleaned from the current scientific literature and from our own experience. An example of these "rules-of-thumb" is the use of a carbon dioxide level of 1000 parts per million (ppm) indoors as a decision point for the determination of adequate amounts of outdoor air.

3. Follow-up Site Visit

If in the background assessment or during the initial site visit a problem has been identified that needs further definition, or if no problem can be isolated, an additional site assessment may be performed, but only in those cases where further work is most likely to result in meaningful recommendations. Subsequent site visits may result in more specific and extensive environmental monitoring for

chemical and/or microbiological contaminants, and/or tracer gas monitoring to evaluate the ventilation system. In addition, follow-up site visits may be used to give building occupants a more detailed or widely distributed questionnaire or to conduct medical testing, if appropriate.

B. DISCUSSION

Through December 1986, we had conducted 446 indoor air quality health hazard evaluations. These do not include our investigations of asbestos-related building problems, but only those where the building occupants were actually experiencing ill-health effects which appeared to be related to air quality. The number of investigations has increased markedly since 1979. This probably has been due to two factors: (1) increased energy conservation measures and (2) increased worker awareness of office environments. We now average about two Health Hazard Evaluation requests per week for indoor air quality investigations.

While the majority (~80%) of our indoor air investigations have been conducted in government and private-sector office buildings, we also have evaluated problems in schools, colleges, and health care facilities.

Commonly, the symptoms and health complaints reported by workers have been diverse and not specific to any particular medical diagnosis or readily associated with a causative agent. A typical spectrum of symptoms has included headaches, varying degrees of itching or burning eyes, irritations of the skin, including rashes, sinus problems, dry and irritated throats and other respiratory irritations. The workplace environment has been typically implicated by virtue of the fact that workers' symptoms normally disappear on weekends, when they are away from the office. At times, these symptoms have been severe enough to result in missed work, reassignment, and even termination. This has caused increased anxiety among the workers and, often times, has made the investigation of these problems even more difficult and frustrating.

Although some of these episodes may be multifactorial, we have been able to classify our evaluations by primary type of problem found: inadequate ventilation (52%); contamination from inside the building (17%); contamination from outside the building (11%); microbiological contamination (5%); contamination from the building fabric (3%); and unknown (12%).

1. Inadequate Ventilation

In 52% of our investigations, the building ventilation has been inadequate. When evaluating building ventilation, we normally use ASHRAE standards for comparison. ASHRAE standard 62-1981, "Ventilation for Acceptable Indoor Air Quality" and 55-1981, "Thermal Environmental Conditions for Human Occupancy" are both used. Some of

the ventilation problems we commonly encounter are: not enough fresh outdoor air supplied to the office space; poor air distribution and mixing which causes stratification, draftiness, and pressure differences between office spaces; temperature and humidity extremes or fluctuations (sometimes caused by poor air distribution or faulty thermostats); and air filtration problems caused by improper or no maintenance to the building ventilation system. In many cases, these ventilation problems are created or enhanced by certain energy conservation measures applied in the operation of the building ventilation. These include reducing or eliminating fresh outdoor air; reducing infiltration and exfiltration; lowering thermostats or economizer cycles in winter, raising them in summer; eliminating humidification or dehumidification systems; and early afternoon shut-down and late morning start-up of the ventilation system.

2. Inside Contamination

Contamination generated by sources inside the office space is the major problem identified in 17% of our investigations. Copying machines are often found to be a significant source. Examples of this type of problem include; methyl alcohol from spirit duplicators; butyl methacrylate from signature machines; and ammonia and acetic acid from blueprint copiers. Still other inside contamination problems we have encountered include; exposures to pesticides; such as chlordane, which were improperly applied; dermatitis from boiler additives such as diethyl ethanolamine; improperly diluted cleaning agents such as rug shampoo; tobacco smoke of all types; combustion gases from sources common to cafeterias and laboratories; and cross-contamination from poorly ventilated sources that leak into other air handling zones.

Contaminants from inside or outside the office space, and from the building fabric are essentially chemical contaminants. Many times, odors are associated with some of these contaminants which may aid in source identification. In most cases, these chemical contaminants have been measured at levels above ambient (normal background) but far below any existing occupational evaluation criteria.

3. Outside Contamination

Contamination from sources outside the office space is the major problem identified in 11% of our investigations. Problems due to motor vehicle exhaust, boiler gases, and previously exhausted air are essentially caused by reentrainment of outside air. This is usually the result of improperly located exhaust and intake vents or periodic changes in wind conditions. Other outside contamination problems include contaminants from construction or renovation projects such as asphalt, solvents, and dusts. Also, gasoline fumes infiltrating the

basement and/or sewage system can sometimes be a problem and these are usually caused by gasoline leaks from ruptured underground tanks at nearby service stations. One of the most common sources of outside contamination has been vehicle exhaust fumes from parking garages being drawn into the building ventilation system.

4. Microbiological Contamination

Five percent of our investigations have involved some type of microbiological contamination. Even though this is not a common cause of office problems, it can result in a potentially severe health condition known as hypersensitivity pneumonitis. This respiratory problem can be caused by bacteria, fungi, protozoa, and microbial products that may originate from ventilation system components. A similar condition known as humidifier fever, most commonly reported in Europe, is also the result of microbiological contamination in ventilation systems. In our investigations, microbiological contamination has commonly resulted from water damage to carpets or furnishings, or standing water in ventilation system components.

Although a variety of disorders (hypersensitivity pneumonitis, humidifier fever, allergic rhinitis, conjunctivitis) can result from microbiological exposure, we generally have not documented the existence of these disorders on the basis of medical or epidemiological data. However, even if visible microbial growth can not be directly related to the health complaints reported, it is a problem that needs to be addressed and corrected.

5. Building Fabric Contamination

Contamination from building materials and products is the major problem in 3% of our investigations. Formaldehyde can off-gas from urea-formaldehyde foam insulation, particle board, plywood, and some glues and adhesives commonly used during construction. Other building fabric contamination problems encountered include: dermatitis resulting from fibrous glass erosion in lined ventilating ducts; various organic solvents from glues and adhesives; and acetic acid used as a curing agent in silicone caulking.

C. CONCLUSION

The major problems[1] identified in our indoor air quality investigations can be placed into three general categories listed with decreasing frequency: inadequate ventilation, chemical contamination, and microbiological contamination. Inadequate ventilation is the single largest problem we see in buildings. Although varied, these ventilation problems commonly can allow a build-up of any contaminants present in the occupied space to the point that adverse health effects are experienced or allow the environment to become annoyingly uncomfortable to the office workers. As our experience has increased over time, we have developed a solution-oriented approach to conducting these evaluations which places a high priority on building ventilation.

1. Although not specifically mentioned, it is also important to recognize tobacco smoke as a potentially major contributor to indoor air quality problems. Tobacco smoke contains several hundred toxic substances, the more important are: carbon monoxide, nitrogen dioxide, hydrogen cyanide, formaldehyde, hydrocarbons, ammonia, benzene, hydrogen sulfide, benzo(a)pyrene, tars, and nicotine. Tobacco smoke can irritate the respiratory system and, in allergic or asthmatic persons, often results in eye and nasal irritation, coughing, wheezing, sneezing, headache, and other related sinus problems. People who wear contact lenses often complain of burning, itching, and tearing eyes when exposed to cigarette smoke. The ASHRAE ventilation guidelines for smoking areas recognize the need to provide additional ventilation (fresh outside air) to maintain air quality.

Section II

SELF-EVALUATION OF INDOOR AIR QUALITY PROBLEMS

After reading the first section, you should have a good idea of what constitutes an indoor air quality problem and what we have found to be some of the common causes. The information in this section will provide guidelines on how to proceed to evaluate your specific question of indoor air quality. Many of these steps you can undertake by yourself or with the assistance of your building maintenance personnel. For some you may need to seek outside assistance from an industrial hygiene or ventilation consultant.

A. INITIAL ASSESSMENT

1. Documentation of Complaints

You will first need to obtain an estimate of the magnitude and distribution of the problem. This may be accomplished by questionnaire (example attached - Appendix I) or interview, or may be evident by how the problem was initially identified. A review of the interview/questionnaire data should help to better define what the complaints are, whether there is any localization of the problem in the building, and any particular circumstances of weather, time of day, day of week, building occupancy, or activity which improve or worsen the problem.

Some questions that you will want to include in the questionnaire or interview outline are:

a. What health complaints have been experienced?

b. When is the first time they were noticed?

c. Is there any specific incident or event that is linked with the initial onset of the complaints? (building renovations, new carpeting, new equipment, etc.)

d. How often do they occur? (several times per day/week, etc.)

e. How long do they last? (minutes/hours, all day)

f. Are there particular times of the day they occur? (morning vs. afternoon, etc.)

g. Do they occur in particular areas of the building vs. others?

h. Are there any specific activities, tasks or unusual circumstances that accompany the problem?

i. When do the health complaints go away? (soon after leaving the building, at home, on weekends)

As you review the data from the questionnaires, or your interviews, you will begin to get an idea of who has experienced health complaints and who has not. In addition, you should also begin to get a clearer picture of what symptoms and complaints are being reported. At this point, you may find it helpful to place individuals into categories to determine; those who definitely have health complaints, those who do not, and those who fall somewhere in between the first two categories. This exercise will at least provide you with numbers, to help determine the extent of the problem. You may also find it helpful to plot this information on a simply drawn sketch of the floor-plan, that identifies individuals in each category according to where their work stations are located. This will provide a graphic display of how complaints are distributed in the building and may help determine if the problem is wide-spread, or localized in a particular area.

You should also keep in mind as you review your data, that it's not unusual to have building occupants with health or comfort complaints from time-to-time; in fact it's normal! For example, the ASHRAE guidelines for thermal comfort strive to satisfy 80% of the building occupants. It would therefore not be unreasonable in a survey to find 20% of the occupants thermally "uncomfortable". Using the same reasoning, not every health complaint will necessarily be air quality related. In summary, your questionnaire data should be interpreted with care.

2. Building Characterization

Another important set of data to be obtained is associated with the building itself. What is known about the building composition and the ventilation system may provide important clues leading to problem solution. To assist you in gathering information about the building and the ventilation system, you should begin by filling in the answers to the questions listed below. (You may find it helpful and necessary to get assistance from persons who are responsible for building and ventilation system maintenance, or from an industrial hygienest or engineer. In addition, access to blue prints, diagrams, and specifications for the ventilation system etc., will also be valuable in answering the questions and assessing potential problem areas.)

a. What is the building's age?_____

What is the basic construction?_____

Number of floors?_____ No. square feet/floor_____

Type of windows?_____ Do they open?_____

b. Who is responsible for the functioning of the building systems? (i.e., ventilation)_____

c. Who is responsible for cleaning the interior of the building?_____

_____

How often is cleaning done?_____

d. Have there been any major renovations or operating changes?_____

What were they?_____

When did they occur?_____

e. Does the building have sprayed or foamed insulation?_____

When was it applied?_____

f. What type of heating system is used?_____

g. What type of cooling system is used?_____

h. What type of humidification system is used?_____

i. How is the total ventilation system operated?_____

_____

j. What floors and rooms are served by each system?_____

_____

k. What type of filtration system is used?_____

How often is it changed/maintenanced?_____

l. How much fresh air is being introduced into the ventilation system?

_____

Does this amount meet system specifications?_____

m. Where are the fresh air inlets and are they functioning properly?

_____

n. Are there any possible sources of contamination located in the general vicinity of the air inlets?_____

o. How likely are contaminants to be drawn into the air inlets due to prevailing winds and inversions?_____

p. How does exhaust air leave the building?_____

q. Is the building being used for the same purpose(s) for which it was designed?_____

r. What type of activities are building occupants engaged in?_____

s. What processes or activities are present in the building that may serve as contaminant sources?_____

How are they vented?_____

3. Walk-Through Survey

A walk-through survey of the building is essential to ensure that information collected by interview and/or questionnaire is accurate. A walk-through survey of the building is also helpful to assess the overall condition of the building and to determine that systems are functioning properly.

The following are some specific problem areas which may be identified and some possible solutions.

a. Specific equipment is giving off solvent fumes, ozone (older dry copiers or sparking electric motors) or heat which is not being adequately dissipated. If this type of problem needs better definition, assistance should be obtained from an industrial hygienist or manufacturing representative.

b. Improper cleaning procedures may be leaving irritating residues in the carpets. Underdilution of industrial strength cleaners can do this. Repeated steam or clean water cleaning can improve or eliminate the problem.

c. Equipment or cleaning products may be giving off solvent fumes (such as typewriter or duplicator cleaners). Also other use of solvent based materials in greater than minimal quantities may be a source of contaminants. Work practices may be able to be modified sufficiently to prevent a problem, or increased dilution ventilation, or local exhaust ventilation may be necessary.

d. Filters and wet areas (humidifiers, dehumidifiers, cooling coils) in the ventilating system may not be cleaned frequently enough. Wet areas may not be draining properly. The most unfortunate outcome can be excessive fungal spores being distributed through the system with some individuals becoming hypersensitive to them and developing hay fever like symptoms or hypersensitivity pneumonitis. Because assessment of spore counts is neither simple nor cheap, cleaning up the system is the preferred first step.

e. The air intake for the ventilating system may be located where it brings in contaminated air. Perhaps it only happens during rush hour traffic, or under specific weather conditions. If it appears to happen only under specific circumstances of short duration, one solution may be to shut off the air intake during the specific time. If it is a more general problem and the major contaminant is carbon monoxide (CO) from auto exhaust or a chimney, a general assessment using low range CO detector tubes can be made. If other substances appear important an industrial hygienist should be consulted. Correction of a building's air intake problem will probably require some structural modification and/or changing traffic patterns.

f. There may be adequate exhaust ventilation with inadequate make-up air. This reduces the efficiency of the exhaust ventilation and may lead to reverse flow in some vents. Under more extreme conditions this may show up as an inrush of outside air whenever a door or window is opened. This condition can also lead to the back-drafting of flue gases from vented natural gas appliances such as hot water heaters and boilers. Such situations will require that more make-up air be supplied. Outside environmental conditions will dictate how much treatment the additional outside air will need. It may be necessary to get professional engineering help to correct this problem.

g. The ventilating system may be out of balance or the temperature control may be inadequate. The feed-back from the building occupants should be quite helpful in pin-pointing these problems. Poor temperature control may be due to inadequate recovery time after the ventilating system has been shut down over night or over the weekend. Another possibility is that windows allow given rooms to pick up a greater solar heat load than the ventilation system can handle. Professional help may be necessary to correct this problem. The desirable temperature is dependent on customary dress, level of physical activity, amount of air movement, and individual variation. There is no one "ideal" temperature, however, ASHRAE guidelines state the operative temperature for thermal acceptability of sedentary or slightly active persons at 50% relative humidity is 73 to 79°F.

h. During winter in the colder climates, indoor air can become excessively dry when heated to comfortable temperatures. This can lead to drying and irritation of mucus membranes of the eyes, nose and throat. It may be necessary to humidify the air in excess of the water vapor added by the occupants' respiration. If the air is to be humidified (ASHRAE guidelines recommend 20-60%), remember the necessity of adequately cleaning the humidifier. Also, recirculating or independent steam humidification is preferable to filter plate type humidifiers.

i. A few individuals may be excessively sensitive, perhaps on an allergic basis, to some substance in the environment (cigarette smoke included). Increased ventilation may handle this, but it may be necessary to either modify the environment more drastically, or to move the worker(s).

j. The pressures of work, interpersonal stresses, management-labor stresses, home-demand vs. work-demand stresses, etc. may result in the workforce being aggravated by minor problems in the work environment which otherwise might simply be ignored.

At this stage of the evaluation, it is quite possible that specific problems such as non-functioning ventilation equipment, poor temperature control, etc. will become evident as a major factor in the problem. If this is the case, the problem or problems should be corrected before the evaluation continues. Correction of problems may or may not require assistance from outside contractors.

In other instances the cause or causes of an indoor air quality problem may not be so easily determined. In such instances we advise initially using a simple approach to evaluating the effectiveness of the ventilation system, including temperature and humidify factors.

B. INTERMEDIATE ASSESSMENT

1. Guidelines

a. Carbon Dioxide Levels

Carbon dioxide (CO_2) is a normal constituent of exhaled breath and, if monitored, can be used as a screening technique to evaluate whether adequate quantities of fresh outdoor air are being introduced into a building or work area. The outdoor, ambient concentration of CO_2 is usually 250-350 ppm. Usually the CO_2 level is higher inside than outside, even in buildings with few complaints about indoor air quality. However, if indoor CO_2 concentrations are more than 1000 ppm (3 to 4 times the outside level), there is probably a problem of inadequate ventilation and complaints such as headaches, fatigue and eye and throat irritation are frequently found to be prevalent. The CO_2 concentration itself is not responsible for the complaints. However, a high concentration of CO_2 may indicate that other contaminants in the building may also be increased and could be responsible for occupant complaints. If CO_2 concentrations are maintained below 600 ppm, with comfortable temperature and humidity levels, complaints about air quality should be minimal. If CO_2 levels are greater than 1000 ppm, widespread complaints may occur and thus 1000 ppm should be used as an upper limit

guideline. This does not mean that if this level is exceeded the building is hazardous or that it should be evacuated, but rather this level should be a guideline that helps maximize comfort for all occupants. Levels between 600 ppm and 1000 ppm are less clearly interpreted.

b. Temperature

ASHRAE has published guidelines describing thermal environmental conditions, (ASHRAE Standard 55-1981, Thermal Environmental Conditions for Human Occupancy). These guidelines are intended to achieve thermal conditions in a given environment, that at least 80% of the persons who occupy that environment will find acceptable or "comfortable." The following is an example of the guideline that ASHRAE recommends for a building environment that is occupied by sedentary or slightly active persons, during the summer season, and when the relative humidity is at 50%: The operating temperture to achieve thermal acceptibility (comfort zone) should be 73° to 79°F. If the operating temperature is outside this range, (at either end-point), then more than 20% of healthy people occupying the area are likely to experience some degree of discomfort.

c. Humidity

The majority of references addressing temperature and humidity levels as they pertain to human health frequently appear in the context of assessing conditions in hot environments. Development of a "comfort" chart by ASHRAE presents a comfort zone considered to be both comfortable and healthful. This zone lies between 73 and 77°F (23 and 25°C) and 20 to 60 percent relative humidity. ASHRAE's recommended design conditions are an effective temperature and dry bulb temperature of 76°F (24.5°C), a relative humidity of 40 percent, and an air circulation rate of less than 45 feet per minute. Effective temperature is an index of relative comfort determined by successive comparisons of individuals to different combinations of temperature, humidity, and air movement. Relative humidity levels below 20 percent are associated with increased discomfort and drying of the mucous membranes.

d. Provision of Adequate Amounts of Outside Air

ASHRAE Standard 62-1981 (Ventilation for Acceptable Indoor Air Quality) recommends guidelines for a wide variety of commercial, institutional, and industrial facilities, including office buildings. For general offices where smoking is not permitted, indoor air quality is considered adequate if outside air is

provided at the rate of 5 cubic feet per minute (CFM) per occupant. Higher ventilation rates are recommended for areas where smoking is permitted because tobacco smoke is one of the most difficult air contaminants to control. Thus, where smoking is allowed, a minimum of 20 CFM of outdoor air per occupant should be provided (ASHRAE 62-1981, Table 3, Section 3.1).

2. Sampling Techniques for Carbon Dioxide, Temperature, Humidity and Air Flow

CO_2 concentrations can easily be determined by using direct reading detector tubes which indicate concentration as a function of length of color change on a sampling tube. Tubes and their associated sampling pumps can be obtained from most local industrial safety equipment supply houses. (See example - Figure 1.)

Plan your sampling locations. Include some areas where there are problems and some where there are not. If there is no difference between areas, pick some from each area of the building.

Start sampling first thing in the morning. You should be among the first people in the building that day. Get baseline samples at all your major sample spots including an outside sample. During the day get representative samples in all your major sampling locations, the frequency determined by the variety and duration of activities. You will probably want to get samples just before the lunch break, particularly if there is a significant decrease in building occupancy at lunch. You will want samples again at the end of the work day just before everyone starts leaving (a lot of in-out traffic would allow more air exchange than during the major part of the day). Depending on the number of sampling sites and activities involved, you may want additional samples at other locations. Record all CO_2 measurements in ppm, by specific location and time of day.

To round out the monitoring, temperature and humidity should be checked at various times and places throughout the day, and if necessary, air flow at vents and return air grills should be evaluated as well. Although wet bulb, dry bulb thermometers can be used, that degree of accuracy is unnecessary. A desk thermometer and relative humidity meter should be adequate. Measurements for air flow are intended to assure that vents are functioning (perhaps intermittently) and to possibly see if the airflow is directed in a suitable direction. Air movement from vents is easily checked with smoke tubes, which are also available from any safety supply house. (See example - Figure II.) Exact measurements are less important at this stage of the evaluation.

3. Interpretation of Results

Your decision to take further action will be determined by what you have found during your day of sampling. The following, represent some of the possible general trends and recommendations for followup, that have been identified through CO_2 monitoring.

a. Initial CO_2 readings inside the building are close to outside readings (250-350 ppm). During the day there are a few rises and falls, but by quitting time readings are still close to initial readings. This suggests that fresh air intake is sufficient. Perhaps the first approach to improving the livability of the building will be to look at temperature and humidity, and check for imbalances in the ventilating system.

b. Initial CO_2 readings inside the building are close to outside readings. During the day levels rise and are definitely elevated by the close of work. This suggests that over 24 hours the air intake is sufficient, but may not be sufficient during the hours the building is occupied.

c. Initial CO_2 readings inside the building are appreciably higher than outside readings. This may simply be due to the shutdown of the ventilating system when the building is unoccupied, or it may be due to underventilation which will require provision of significantly more fresh air. In this case it will be necessary to arrange to have the system left on for several hours after the occupants leave.

d. Temperature, humidity and air flow readings compare unfavorably with specified guidelines. Steps should be taken to adjust systems to comply with the guidelines.

4. Contaminant Sources

Additional evaluation of point sources of contaminants also may be necessary. If point sources such as copy machines, blue print machines, solvents, etc. are suspected to be causing the problem, the assistance of an industrial hygienist, or a manufacturing representative, may be necessary.

5. General Recommendations for the Correction and Prevention of Indoor Air Quality Problems

a. Ensure an Adequate Fresh Outdoor Air Supply

This has been shown to be the single most effective method of correcting and preventing problems and minimizing complaints

related to poor indoor air quality. Even if a specific contaminant is identified (such as formaldehyde) dilution may be the most practical way of reducing exposures.

(1) If mechanical ventilation is on, check that the outdoor air supply louvers are open. They may have been closed deliberately to save energy, or automatically by a faulty control system.

(2) Fresh, outdoor air should be adequately distributed to all office areas during the entire time they are occupied, at a minimum rate of 5 cubic feet per minute (cfm) of fresh air per person. In areas where smoking is permitted this rate should be increased to 20 cfm per person. These levels are specified in the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 62-1981, "Ventilation for Acceptable Indoor Air Quality." If the exact number of occupants is not known, an estimate of 7 persons per 1000 ft^2 may be used to calculate ventilation requirements. Fresh air ventilation rates should be measured on a regular basis to ensure they remain at optimal levels.

(3) During occupancy periods it should be assured that outdoor air dampers (vents) do not close, nor do fans of air handling units turn off at certain times of the day or within certain temperature ranges. These problems may mean that modifications must be done on the ventilation system so that it can handle very cold or very warm air.

(4) All air vents (diffusers) should be checked to ensure they are open and unobstructed, providing for adequate air mixing in each supplied area. Also the diffusers should be adjusted so that occupants are not sitting in a direct stream of air. Often the air stream temperature will be less than body temperature and be uncomfortably cool.

(5) If the office layout has been changed (e.g., by erecting partitions, room dividers, or new walls), care must be taken that adequate air flow is still being provided.

(6) An insufficient supply of make-up (fresh) air can cause the building to be at a negative pressure with respect to the outdoor atmosphere, creating a situation where untreated air and/or contaminants can infiltrate from outside. This can be determined by observing the direction of air movement at windows and doors. In order to prevent this problem, particular attention must be paid to proper balancing of the air supply and exhaust systems.

(7) A program of preventive maintenance must be in place for all ventilation equipment, including checking; damper positions and functioning belts, baffles, ductwork, and system balance. Actual air flow supplied to occupied areas must be measured and any necessary maintenance or repairs done to comply with the original design specification and the ASHRAE Guidelines.

(8) If possible, gauges should be installed to provide information on air volumes delivered by supply and return fans, and maintenance people should be trained to read them and respond appropriately.

(9) Filters on air handling units must be replaced at regular intervals. Permanent static pressure gauges are helpful in deciding when to change filters. Filters should have a moderate efficiency rating, as measured by the ASHRAE atmospheric dust spot test, and should be of an extended surface type. Pre-filters (e.g., roll type) should be used before air passage through higher efficiency filters.

b. Eliminate or Control all Known and Potential Sources of Chemical Contaminants

(1) Use local exhaust where appropriate to capture and remove contaminants generated by specific processes. In some instances, the manufacturer of office machines will advise whether exhaust ventilation is recommended.

(2) General room air from areas where contaminants are generated (e.g., a printing area where solvents are used) should be exhausted directly outdoors rather than recirculated into the rest of the building's air supply.

(3) Check to be sure outside air intakes or other building vents or openings are not located in close proximity to potential sources of contamination (e.g., places where motor vehicle emissions collect, downwind of exhausts, cooling towers, etc.). If necessary, raise stacks or relocate intakes or exhausts.

(4) Isolate areas of renovation, painting, carpet laying, etc., from occupied, non-construction areas through use of physical barriers and separation of involved ventilation systems. If possible, perform this type of work on evenings and weekends. Supplying a maximum amount of ventilation to the areas initially on a 24 hour basis can assist in rapid dispersion of contaminant levels.

(5) Pesticides should be applied only while the building is unoccupied, and the building should be thoroughly ventilated before reoccupation.

(6) Eliminating or reducing contamination of the air supply with cigarette smoke is a recognized method of improving the indoor environment. Cigarette smoke contains many substances (e.g., carbon monoxide, formaldehyde, particulates) that pollute the air and may build up in poorly ventilated areas. Bans on smoking or restriction of smoking to designated areas (preferably that have their air supply exhausted rather than recirculated) are methods of dealing with this pollution source.

c. Eliminate or Control all Known and Potential Sources of Microbial Contaminants

(1) Promptly detect and permanently repair all areas where water collection or leakage has occurred.

(2) Maintain relative humidity at less than 60% in all occupied spaces and low-air-velocity plenums. During the summer, cooling coils should be run at a low enough temperature to properly dehumidify conditioned air.

(3) Check for, correct, and prevent further accumulation of stagnant water under cooling deck coils of air handling units, through proper inclination and continuous drainage of drain pans.

(4) Use only steam, not water, as the moisture source for humidifiers in the ventilation systems. Steam should not be contaminated with volatile amines (sometimes used as rust inhibitors).

(5) Once contamination has occurred (through dust or dirt accumulation or moisture-related problems) downstream of heat exchange components (as in ductwork or plenum), additional filtration downstream may be necessary before air is introduced into occupied areas.

(6) Water-damaged porous furnishings, including carpets, upholstery and ceiling tiles, should be discarded rather than disinfected, to effectively eliminate microbial contamination.

(7) Air handling units should be constructed so that equipment maintenance personnel have easy and direct access to both

heat exchange components and drain pans for checking drainage and cleaning. Access panels or doors should be installed where needed.

(9) Non-porous surfaces where moisture collection has promoted microbial growth (e.g., drain pans, cooling coils) should be cleaned and disinfected with detergents, chlorine-generating slimicides (bleach), and/or proprietary biocides. Care should be taken to insure that these cleaners are removed before air handling units are reactivated.

C. CONCLUSIONS AND FOLLOW-UP ASSESSMENTS

If sufficient information has been obtained to identify the problem or problems, corrective action can be taken. Depending on the complexity of the problem, it may or may not be necessary to call in expert help, such as that of an engineering/ventilation consultant or an industrial hygienist. Keep in mind that early recognition of a problem, with a timely and systematic evaluation, are key factors to a quick and effective resolution.

In summary:

1. Make a log of employee complaints.

2. Assess the ventilation system for the building, including temperature and humidity factors.

3. Identify and evaluate sources of contaminants.

4. Correct identified deficiencies and control or eliminate identified sources of contaminants.

5. Monitor complaints after remedial action has been taken.

Section III

INDOOR AIR QUALITY CONSULTATION SERVICES

If further evaluation is needed to resolve the problem or if technical expertise is needed to complete any of the self-evaluation steps outlined above, on-site assistance is available from the following sources.

1. Local or State Health Departments or Consulting Programs (Availability and expertise vary with locality and state)

2. Private Consultants (availability and expertise vary)

   a. A list of industrial hygiene consultants who are members of the American Industrial Hygiene Association (AIHA) is available from the AIHA:

      American Industrial Hygiene Association
      475 Wolf Ledges Parkway
      Akron, Ohio 44311-1087

   b. A list of engineering firms certified by the National Environmental Balancing Bureau (NEBB) is available from the NEBB:

      National Environmental Balancing Bureau
      8224 Old Courthouse Road
      Vienna, Virginia 22180

3. NIOSH - Health Hazard Evaluation Program:

      National Institute for Occupational Safety and Health
      Hazard Evaluations and Technical Assistance Branch
      4676 Columbia Parkway
      Cincinnati, Ohio 45226

Additional background information concerning indoor air quality can be obtained from the following sources.

1. Environmental Protection Agency
   820 Quincy Street, N.W.
   Washington, D.C. 20011

2. Consumer Product Safety Commission
   Washington, D.C. 20207

3. Office of Scientific and Technical Information
   Department of Energy
   P.O. Box 62
   Oak Ridge, Tennessee 37830

6. Federal Employee Occupational Health Program (contact your regional Public Health Service Office)

Appendix I

INDOOR AIR QUALITY QUESTIONNAIRE

1. Complaints Yes____ No____
(If yes, please check)

____ temperature too cold
____ temperature too hot
____ lack of air circulation (stuffy feeling)
____ noticeable odors
____ dust in air
____ disturbing noises
____ other (specify)_____

2. When do these problems occur?

____ morning
____ afternoon
____ all day
____ no noticeable trend

____ daily
____ specific day(s) of the week
which day(s)?_____
_____

3. Health Problems or Symptoms

Describe in three words or less each symptom or adverse health effect you experience more than two times per week.

Example: runny nose

Symptom #1 _____

Symptom #2 _____

Symptom #3 _____

Symptom #4 _____

Symptom #5 _____

Symptom #6 _____

Do the above symptoms clear up within 1 hour after leaving work?
Yes ____ No ____

If no, which symptom or symptoms persist (noted at home or at work) throughout the week? Please indicate by drawing a circle around the symptom number below.

Symptom: #1 #2 #3 #4 #5 #6

Do you have any health problems or allergies which might account for any of the above symptoms? Yes ____ No ____

If yes, please describe._____

_____

_____

(over)

4. Do any of the following apply to you?

_____ wear contact lenses
_____ operate video display terminals at least 10% of the work day
_____ operate photocopier machines at least 10% of the work day
_____ use or operate other special office machines or equipment (specify)

_____

_____ currently taking medication
reason for taking medication (specify) _____

_____

5. Do you smoke? Yes_____ No_____
6. Do others in your immediate work area smoke? Yes_____ No_____

7. Your office or suite number is _____

8. What is your job title or position?_____

9. Briefly describe your primary job tasks. _____

_____

_____

10. Can you offer any other comments or observations concerning your office environment? (optional)

_____

_____

_____

_____

_____

_____

_____

_____

11. Your name? (optional) _____

12. Your office phone number? (optional)_____

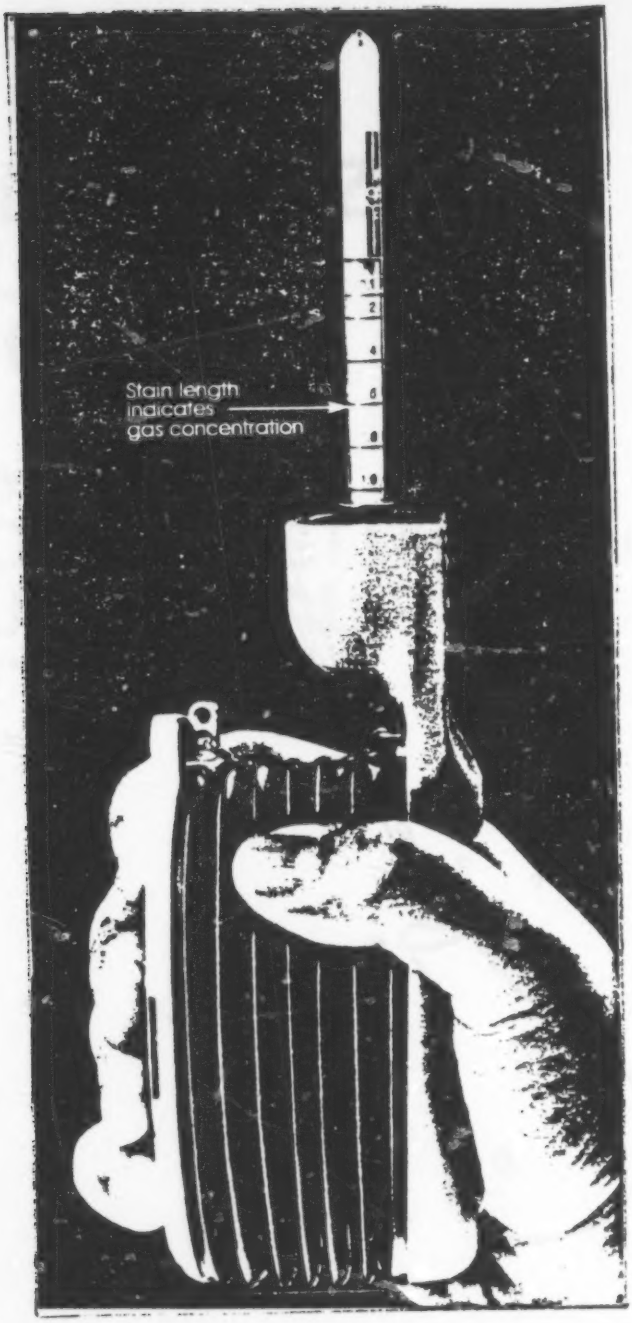

Figure I

Direct Reading Detector Tube and Pump

Figure II

NIOSH

the HEALTH HAZARD EVALUATION PROGRAM

of the NATIONAL INSTITUTE for OCCUPATIONAL SAFETY and HEALTH

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health
Division of Surveillance, Hazard Evaluations and Field Studies

REQUESTS FOR HEALTH HAZARD EVALUATIONS

(Code of Federal Regulations, Title 42, Part 85, 37 FR 23640, November 7, 1972; amended at 45 FR 2651, January 14, 1980)

PART 85—REQUESTS FOR HEALTH HAZARD EVALUATIONS

Sec.

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85.10 Imminent dangers.
85.11 Notification of determination to employers, affected employees, and Department of Labor.
85.12 Subsequent requests for health hazard evaluations.

AUTHORITY: Sec. 8(g), 84 Stat. 1600; 29 U.S.C. 657(g) and sec. 508, 83 Stat. 803; 30 U.S.C. 957.

SOURCE: 37 FR 23640, Nov. 7, 1972, unless otherwise noted.

§ 85.1 Applicability.

This Part 85 applies to health hazard evaluations requested by any employer or authorized representative of employees under section 20(a)(6) of the Occupational Safety and Health Act of 1970 or section 501(a)(11) of the Federal Mine Safety and Health Act of 1977. This part is not intended to preclude the use of other channels of communication with the National Institute for Occupational Safety and Health to obtain information and technical assistance concerning toxic substances or physical agents.

[45 FR 2652, Jan. 14, 1980]

§ 85.2 Definitions.

Any term defined in the Occupational Safety and Health Act of 1970 or the Federal Mine Safety and Health Act of 1977 and not defined below shall have the meaning given it in the respective Acts. As used in this part:

"OSH Act" means the Occupational Safety and Health Act of 1970 (29 U.S.C. 651, et seq.).

"FMSH Act" means the Federal Mine Safety and Health Act of 1977 (30 U.S.C. 801, et seq.).

"Authorized representative of employees" means any person or organization meeting the conditions specified in § 85.3-1(e) (1), (2), or (3).

"Employee" has the same meaning as stated in the OSH Act and for the purposes of this part includes "miner" as defined in the FMSH Act.

"Employer" has the same meaning as stated in the OSH Act and for the purposes of this part includes "Operator" as defined in the FMSH Act.

"Health hazard evaluation" means the investigation and the determination of potentially toxic or hazardous effects of: (a) any substance normally used or found in any place of employment to which the OSH Act is applicable, or (b) any substance or physical agent normally used or found in any place of employment to which the FMSH Act is applicable.

"Investigation" means a physical inspection of the place of employment under section 8 of the OSH Act or section 103 of the FMSH Act and includes inspection, sampling, observations, review of pertinent records, and other measurements reasonably necessary to determine whether any substance or physical agent found in the place of employment has potentially toxic or hazardous effects in the concentrations or levels used or found.

"NIOSH" means the National Institute for Occupational Safety and Health, Center for Disease Control, Public Health Service, Department of Health and Human Services.

"NIOSH officer" means a NIOSH employee who has been authorized by the Director, NIOSH, to conduct investigations according to this part.

"Physical agent" means any condition produced by the environment and/or work processes that can result in hazardous effects as defined in this section. Examples of physical agents are noise, temperature, illumination, vibration, radiation, and pressure.

"Place of employment" means any coal or other mine, factory, plant, establishment, construction site, or other area, workplace, or environment where work is performed by any employee of an employer.

"Substance" means any chemical or biological agent or dust which has the potential to produce toxic effects.

"Toxic effects" or "hazardous effects" are those effects which result in short- or long-term disease, bodily injury, affect health adversely, or endanger human life.

[45 FR 2652, Jan. 14, 1980]

§ 85.3 Procedures for requesting health hazard evaluations.

(a) Requests for health hazard evaluations should be addressed to the National Institute for Occupational Safety and Health as follows:

(1) *Requests from general industry.* Hazard Evaluations and Technical Assistance Branch, Division of Surveillance, Hazard Evaluations, and Field Studies, NIOSH, 4676 Columbia Parkway, Cincinnati, OH 45226.

(2) *Requests from mining industry.*

Environmental Investigations Branch, Division of Respiratory Disease Studies, NIOSH, 944 Chestnut Ridge Road, Morgantown, WV 26505.

(b) Requests for health hazard evaluations shall be submitted in writing and signed by either: (1) The employer in whose place of employment the substance or physical agent is normally found, or (2) an authorized representative of employees (see § 85.3-1(e)) in the place of employment where the substance or physical agent is normally found.

[45 FR 2653, Jan. 14, 1980]

§ 85.3-1 Contents of a request for health hazard evaluation.

Each request for health hazard evaluation shall contain:

(a) The requester's name, address, and telephone number, if any.

(b) The name and address of the place of employment where the substance or physical agent is normally found.

(c) The specific process or type of work which is the source of the substance or physical agent, or in which the substance or physical agent is used.

(d) Details of the conditions or circumstances which prompted the request.

(e) A statement, if the requester is not the employer, that the requester is:

(1) An authorized representative or an officer of the organization representing the employees for purposes of collective bargaining; or

(2) An employee of the employer and is authorized by two or more employees employed in the same place of employment to represent them for purposes of these Acts (each such authorization shall be in writing and a copy submitted with the request for health hazard evaluation); or

(3) One of three or less employees employed in the place of employment where the substance or physical agent is normally found.

(f) A statement indicating whether or not the name(s) of the requester or those persons who have authorized the requester to represent them may be revealed to the employer by NIOSH.

(g) The following supplementary information if known to the requester:

(1) Identity of each substance or physical agent involved;

(2) The trade name, chemical name, and manufacturer of each substance involved;

(3) Whether the substance or its container or the source of the physical agent has a warning label; and

(4) The physical form of the substance or physical agent, number of people exposed, length of exposure (hours per day), and occupations of exposed employees.

NOTE: NIOSH has developed two forms entitled "Request for Health Hazard Evaluation" and "Request for Mining Health Hazard Evaluation" to assist persons in requesting evaluations. The forms are available upon request from the offices listed in § 85.3(a) (1) and (2) or from the Regional Consultant for Occupational Safety and Health in any Regional Office of the Department of Health and Human Services

[45 FR 2653, Jan. 14, 1980]

§ 85.4 Acting on requests.

(a) Upon receipt of a request for health hazard evaluation submitted under this part, NIOSH will determine whether or not there is reasonable cause to justify conducting an investigation.

(b) If NIOSH determines that an investigation is justified, a NIOSH officer will inspect the place of employment, collect samples where appropriate, and perform tests necessary to the conduct of a health hazard evaluation, including medical examinations of employees.

(c) If NIOSH determines that an investigation is not justified, the requester will be notified in writing of the decision.

[45 FR 2653, Jan. 14, 1980]

§ 85.5 Authority for investigations.

(a) NIOSH officers who have been issued official NIOSH credentials (Form No. CDC/NIOSH 2.93) are authorized by the Director, NIOSH, under sections 20(a) (6) and 8 of the OSH Act and sections 501(a)(11) and 103 of the FMSH Act: To enter without delay any place of employment for the purpose of conducting investigations of all pertinent processes, conditions, structures, machines, apparatus, devices, equipment, records, and materials within the place of employment; and to conduct medical examinations, anthropometric measurements, and functional tests of employees within the place of employment as may be directly related to the specific health hazard evaluation being conducted. Investigations will be conducted in a reasonable manner, during regular working hours or at other reasonable times and within reasonable limits. In connection with any investigation, the NIOSH officers may question privately any employer, owner, operator, agent, or employee from the place of employment; and review, abstract, and duplicate records required by the Acts and regulations and any other related records.

(b) Areas under investigation which contain information classified by any agency of the United States Government in the interest of national security will be investigated only by NIOSH officers who have obtained the proper security clearance and authorization.

[45 FR 2653, Jan. 14, 1980]

§ 85.6 Advance notice of visits.

(a) Advance notice of visits to the place of employment may be given to expedite a thorough and effective investigation. Advance notice will not be given when, in the judgment of the NIOSH officer, giving such notice would adversely affect the validity and effectiveness of the investigation.

(b) Where a request in accordance with this part has been made by an authorized representative of employees, advance notice in accordance with paragraph (a) of this section will be given by NIOSH to the requester, the representative of the employees for purposes of collective bargaining if such representative is other than the requester, and to the employer.

(c) Where a request in accordance with this part has been made by any employer, advance notice will be given by NIOSH to the employer. Upon the request of the employer, NIOSH will inform the authorized representative of employees of the visit: *Provided*, The employer furnishes NIOSH in writing with the identity of such representative and with such information as is necessary to enable NIOSH promptly to inform such representative of the visit.

§ 85.7 Conduct of investigations.

(a) Prior to beginning an investigation, NIOSH officers shall present their credentials to the owner, operator, or agent in charge at the place of employment, explain the nature, purpose, and scope of the investigation and the records specified in § 85.5 which they wish to review. Where the investigation is the result of a request submitted by an authorized representative of employees, a copy of the request shall be provided to the employer, except where the requester or any person authorizing the requester pursuant to § 85.3-1(e)(2) has indicated that NIOSH not reveal his name to the employer, in which case a summary of the basis for the request shall be provided to the employer.

(b) At the commencement of an investigation, the employer should precisely identify information which can be obtained in the workplace or workplaces to be inspected as trade secrets. If the NIOSH officer has no clear reason to question such identification, such information shall not be disclosed except in accordance with the provisions of section 20(a)(6) and sec-

tion 15 of the OSH Act or section 501(a)(11) of the FMSH Act. However, if NIOSH at any time questions such identification by an employer, not less than 15 days' notice to an employer shall be given of the intention to remove the trade secret designation from such information. The employer may within that period submit a request to the Director, NIOSH, to reconsider this intention and may provide additional information in support of the trade secret designation. The Director, NIOSH, shall notify the employer in writing of the decision which will become effective no sooner than 15 days after the date of such notice.

(c) NIOSH officers are authorized to collect environmental samples and samples of substances, or measurements of physical agents to take or obtain photographs related to the purpose of the investigation, employ other reasonable investigative techniques, including medical examinations of employees with the consent of such employees, and to question privately any employer, owner, operator, agent, or employee. The employer shall have the opportunity to review photographs taken or obtained for the purpose of identifying those which contain or might reveal a trade secret.

(d) NIOSH officers shall comply with all safety and health rules and practices at the place of employment being investigated, and they shall provide and use appropriate protective clothing and equipment. In situations requiring specialized or unique types of protective equipment, such equipment shall be furnished by the employer.

(e) The conduct of investigations shall be such as to preclude unreasonable disruption of the operations of the employer's establishment.

[37 FR 23640, Nov. 7, 1972, as amended at 45 FR 2653, Jan. 14, 1980]

§ 85.8 Provision of suitable space for employee interviews and examinations; identification of employees.

An employer shall, in request of the NIOSH officer, provide suitable space, if such space is reasonably available, to NIOSH to conduct private interviews with, and examinations of, employees. NIOSH officers shall consult with the employer as to the time and place of the medical examination and shall schedule such examinations so as to avoid undue disruption of the operations of the employer's establishment. NIOSH shall conduct, and assume the medical costs of, examinations conducted under this part.

§ 85.9 Representatives of employers and employees; employee requests.

(a) NIOSH officers shall be in charge of investigations. Where the request for a health hazard evaluation has been made by an authorized representative of employees, a representative of the employer and a representative authorized by his employees who is an employee of the employer shall be given an opportunity to accompany the NIOSH officer during the initial physical inspection of any workplace for the purpose of aiding the investigation by identifying the suspected hazard. The NIOSH officer may permit additional employer representatives and such additional representatives authorized by employees to accompany him where he determines that such additional representatives will further aid the investigation. However, if in the judgment of the NIOSH officer, good cause has been shown why accompaniment by a third party who is not an employee of the employer is reasonably necessary to the conduct of an effective and thorough investigation of the workplace, such third party may accompany the NIOSH officer during the inspection: *Provided, however,* That access by such persons to areas described in paragraph (d) of this section shall be in accordance with the requirements of such provision, and access to areas described in paragraph (e) of this section shall be with the consent of the employer. A different employer and employee representative may accompany the officer during each different phase of an inspection if this will not interfere with the conduct of the investigation.

(b) NIOSH officers are authorized to resolve all disputes as to who is the representative authorized by the employer and employees for the purpose of this section. If there is no authorized representative of employees, or if the NIOSH officer is unable to determine with reasonable certainty who is such representative, he shall consult with a reasonable number of employees concerning matters directly related to the health hazard evaluation.

(c) NIOSH officers are authorized to deny the right of accompaniment under this section to any person whose conduct interferes with a fair and orderly physical inspection.

(d) With regard to information classified by an agency of the U.S. Government in the interest of national security, only persons authorized to have access to such information may accompany an officer in areas containing such information.

(e) Upon request of an employer, any representative authorized under this § 85.9 by employees in any area containing trade secrets shall be an employee in that area or an employee authorized by the employer to enter that area.

§ 85.10 Imminent dangers.

Whenever, during the course of, or as a result of, an investigation under this part, the NIOSH officer believes that there is a reasonable basis for an allegation of an imminent danger, NIOSH will immediately advise the employer and those employees who appear to be in immediate danger of such allegation and will inform appropriate representatives of the Department of Labor or the State agency designated under section 18(b) of the OSH Act.

[37 FR 23640, Nov. 7, 1972, as amended at 45 FR 2653, Jan. 14, 1980]

§ 85.11 Notification of determination to employers, affected employees and Department of Labor.

(a) Upon conclusion of an investigation, NIOSH will make a determination concerning the potentially toxic or hazardous effects of each substance or physical agent investigated as a result of the request for health hazard evaluation. At a minimum, the determination will: (1) Identify each substance or physical agent involved and describe, where appropriate, the concentrations or levels of the substance or physical agent found in the place of employment and the conditions of use, and (2) state whether each substance or physical agent has potentially toxic or hazardous effects in the concentrations or levels found, as well as the basis for the judgments.

(b) Copies of the determination will be mailed to the employer and to the authorized representatives of employees.

(c) Except as hereinafter provided, the employer shall post a copy of the determination for a period of 30 calendar days at or near the workplace(s) of affected employees. The employer shall take steps to insure that the posted determinations are not altered, defaced, or covered by other material during such period. The employer will not be required to post the determination if the employer requests that copies of the determination be mailed to affected employees and furnishes NIOSH with a list of the names and mailing addresses of the employees employed in the workplace(s) designated by the NIOSH Officer. In the latter event, NIOSH will mail such copies to affected employees at the mailing addresses provided by the employer.

(d) For purposes of this section, the term "affected employees" means those employees determined by NIOSH to be exposed to the substance(s) or physical agent(s)

which is the subject of the health hazard evaluation.

(e) Copies of determinations made under the OSH Act will be forwarded to the Department of Labor and the appropriate State agency designated under section 18(b) of the OSH Act. Copies of determinations made under the FMSH Act will be forwarded to the Mine Safety and Health Administration of the Department of Labor; the Bureau of Mines, Department of the Interior; and the State agency which, in the judgment of NIOSH, would benefit the most from the information. If NIOSH determines that any substance or physical agent has potentially toxic or hazardous effects at the concentrations or levels at which it is used or found in a place of employment, and the substance or physical agent is not covered by a safety or health standard established under section 6 of the OSH Act or section 101 of the FMSH Act, NIOSH will immediately submit the determination to the Secretary of Labor, together with all pertinent criteria.

[37 FR 23640, Nov. 7, 1972, as amended at 45 FR 2653, Jan. 14, 1980]

§ 85.12 Subsequent requests for health hazard evaluations.

If a request is received for a health hazard evaluation in a place of employment in which an evaluation under this part was made previously, NIOSH may make another investigation if, as a result of the passage of time or additional information, another investigation would be consistent with the purposes of the Acts.

[45 FR 2654, Jan. 14, 1980]

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

REQUEST FOR HEALTH HAZARD EVALUATION

This form is provided to assist in registering a request for a health hazard evaluation with the U.S. Department of Health and Human Services as provided in Section 20(a)(6) of the Occupational Safety and Health Act of 1970 and 42 CFR Part 85. (See Statement of Authority on Reverse Side.)

Establishment Where Possible Hazard/Problem Exists _____

Address
Street _____ Telephone _____
City _____ State _____ Zip Code _____

1. Specify the particular building or worksite where the possible hazard/problem is located.

_____

2. Specify the name, title, and phone number of the employer's agent(s) in charge.

_____

3. What Product or Service does the Establishment Produce?

_____

4. Describe briefly the possible hazard/problem which exists by completing the following:

Identification of Toxic Substance(s) _____

Trade Name(s) (If Applicable) _____ Chemical Name(s) _____

_____

_____

Manufacturer(s) _____

Does the material have a warning label? ___ Yes ___ No. If yes; attach copy of label or a copy of the information contained on the label.

Physical Form of Substance(s): ☐ Dust ☐ Gas ☐ Liquid ☐ Mist ☐ Other

How are you exposed? ☐ Breathing ☐ Swallowing ☐ Skin Contact

Number of People Exposed _____ Length of Exposure (Hours/Day) _____

Occupations of Exposed Employees _____

_____

5. Using the space below describe further the nature of the conditions or circumstances which prompted this request and other relevant aspects which you may consider important, such as the nature of the illness or symptoms of exposure, the concern for the potentially toxic effects of a new chemical substance introduced into the workplace, etc. _____

_____

_____

_____

OMB No. 0920-0102,
Expires 7/31/89

6. (a) To your knowledge has this substance been considered previously by any Government agency? _____ (b) If so, gove the name and address of each. _____

_____

_____

(c) and, the approximate date it was so considered. _____

7. (a) Is a similar request currently being filed with or under investigation by any other Government (State or Federal) agency? _____ (b) If so, give the name and address of each _____

_____

8. Requester –
The undersigned Requester believes that a substance (or substances) normally found in the place of employment may have potentially toxic effects in the concentrations used or found.

Signature _____ Date _____

Typed or Printed Name _____ Phone: Home– _____

Address Street _____ Business– _____

City _____ State _____ Zip Code _____

Check One:

☐ I am an Employer Representative

☐ I am an Authorized Representative of, or an officer of the organization representing the employees for purposes of collective bargaining. State the name and address of your organization. _____

_____

☐ I am an employee of the employer and an Authorized Representative of two or more employees in the workplace where the substance is normally found. Signatures of authorizing employees are below:

Name _____ Phone _____

Name _____ Phone _____

☐ I am one of three or less employees in the workplace where the substance is normally found.

Please indicate your desire: ☐ I do not want my name revealed to the employer.

☐ My name may be revealed to the employer.

Authority:
Section 20(a)(6) of the Occupational Safety and Health Act, (29 U. S. C. 669(a)(6)) provides as follows: The Secretary of Health and Human Services shall . . . determine following a written request by any employer or authorized representative of employees, specifying with reasonable particularity the grounds on which the request is made, whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found; and shall submit such determination both to employers and affected employees as soon as possible. If the Secretary of Health and Human Services determines that any substance is potentially toxic at the concentrations in which it is used or found in a place of employment, and such substance is not covered by an occupational safety or health standard promulgated under section 6, the Secretary of Health and Human Services shall immediately submit such determination to the Secretary of Labor, together with all pertinent criteria.

For further information:
Telephone: AC 513-841-4382

Send the completed form to:

National Institute for Occupational Safety and Health
Hazard Evaluation and Technical Assistance Branch
4676 Columbia Parkway
Cincinnati, Ohio 45226